METALS and ALLOYS

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This Month

ENGINEERING FILE FACTS

Every Month

Metallurgical Engineering Digest

by Harold A. Knight
Associate Editor

The war will be long — No, the war will be short. . . . Why post-war plan now? . . . Getting more production out of existing blast furnaces and open-hearths. . . . Foremen and bosses operate during lunch time. . . . Let brick kilns and cement plants make sponge iron.

Read our jingle and you'll with rhythm tingle. . . . How about our iron ore supply and, oh yes, our bauxite? . . . Eberstadt, another good man gone from Washington. . . . CMP run by the boys who understand materials "flow."

Metallurgical war problems "will be tougher tomorrow." . . . Our machine tool builders may be looking for work. . . . What's ahead for 1943?

Focusing on the War's End

Undoubtedly the ultimate in desire of all human hearts is the ending of the present war. It is a bold commentator indeed who will attempt any prediction as to dates, months or, perhaps, even years. Aside from humanitarian desires, he who can best judge the date and make his peace plans accordingly will profit most.

Bold as we are, we will not attempt in print such prophesy. But, perhaps one is justified in thinking out loud some of the pros and cons. Among the arguments that the war will still last years, rather than months, are these considerations:

Germany is still a country rather inaccessible to the Allies in view of the several buffer countries surrounding her. The trouncing given by Russia at Stalingrad, Rostov, Kharkov, etc. was not a fair test of German military ability — she was in territory far from home; her military moves were gambles rather than sound military strategy. As her lines become re-established on the Dnieper, or closer home; as solid military principles supplant Hitler's maniacal brainstorms; as Russia gets worn down from sheer exhaustion from such powerful punching; as the United Nations find more issues over which to disagree; and as Washington gets more and more muddled, Germany may catch its second wind.

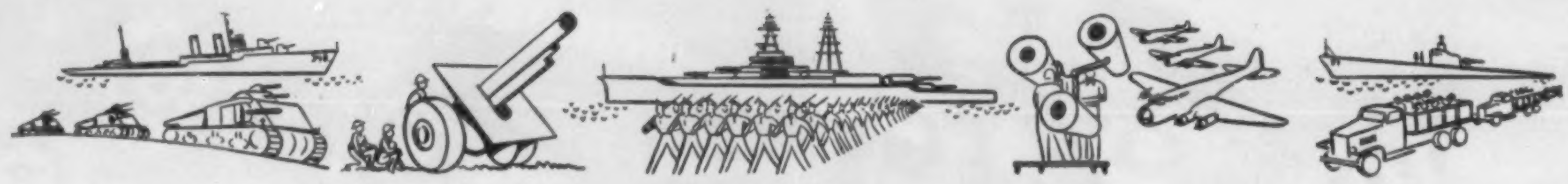
Moreover, the submarine menace may never be curbed — it wasn't during the first war, and progress now seems slow. Improvement in quality and quantity of pig boats keeps up with improved techniques of sinking them.

Pro a Quick War's End

Arguments for comparatively speedy war's end may run as follows: Hitler is a fair weather genius. When things go seriously wrong, he will crack — perhaps commit suicide. Knowing that one is on the right side of a moral issue gives spiritual strength and morale. Surely even the Germans will soon realize, if they have not already, that they are the world's worst-hated people, and rightly so; that they have committed heinous crimes, from the standpoint of both the civil and moral code — crimes for which certain retribution lurks.

You perhaps say that, knowing the world's hate, they will fight on desperately, but do they not have an innate knowledge now that they are beaten? Surrender now, and the lives of 5,000,000 German soldiers may be saved. Surrender two years hence, and they will receive the same harsh, or even harsher punishment than by giving up now.

Bombings from the West, Russia on the East, the United Nations in North Africa and rebellient Norway at the North will give the most stout-hearted German claustrophobia. America's



weapons are increasing with geometrical rapidity, and her soldiers are gaining military skills apace.

Then, there is the spectre of 1918. A melon, sound on the outside, is often rotten in the interior — so is Germany. Most major wars of modern times have lasted four years: our Civil War, the first World War. That would mean this war would end Sept. 1, 1943.

Why this Post-War Planning Now?

Don't the majority of our best brains expect a rather near ending? If not, why this feverish era of post-war planning on the part of the Government and private industry? If the war is to last two years more, why post-war plan now?

Such two years would be equivalent to ten years in peace time — things change so rapidly during a world war, and post-war plans made now would seem like Rip Van Winkle emerging from the Catskills. Are we merely talking a long war to be on the safe side and keep the carefree element of the public scared into sweat?

All idle talk, perhaps — yet there's no harm in thinkin'! Meanwhile, to get on with the job.

Since steel and other materials cannot be spared for building new plants and equipment, attention seems focused on getting more production out of existing facilities. Blast furnaces have been objects of considerable research. Thus, in the Cleveland district production record after record has been broken each month. Our informant says new and improved methods of loading and reducing ore are responsible.

Getting More Out of the Blast Furnace

Harvey Davis, head of the Office of Production Research and Development, told the mining engineers' convention that greater pig iron production would result if fine particles of ore were sintered, preventing their flying out the flues.

About the same time, Harold L. Ickes, Solid Fuel Co-ordinator, presented a plan, alleged to increase production 50 tons per furnace per day through improvement in the quality and uniformity of coke. The program calls for greater care in mining to eliminate dirty coal, construction of new cleaning plants and research aimed to improve methods of removing sulphur.

Mr. Davis also told of experiments to increase the production of the open-hearth furnace, one plan being to use more flux and to provide outlets for periodic overflows and drainage from the hearth of this flux, plus impurities absorbed by it.

We Speed Fabrication Also

In the fabrication fields, various devices are constantly inaugurated for speeding output. Take the Irving Subway Grating Co., Long Island City, which makes emergency airplane landing mats. When the regular operators leave their machines for half-hour eating periods, the foremen and gang bosses take over as relief operators, thus increasing production 7 per cent.

Then, there still goes on the program to convert civilian goods makers to war production. It is being suggested seriously, for instance, that brick kilns and cement plants make sponge iron from nearby iron deposits, it being estimated that iron production would thereby be increased 500,000 to 1,000,000 tons yearly.

We Survey Our Ores

A concentrated drive is always on to uncover new deposits of ores and minerals and estimate present-known reserves. The marked acceleration in the exhaustion of merchantable iron ore, particularly Mesabi open-pit ore, again has brought to the foreground the question of the life of the Lake Superior high-grade ore reserves.

A survey was made by the National Industrial Conference Board, Inc., New York, with findings published under date of February, 1943, signed by H. E. Hansen, Div. of Industrial Economics. Conclusions are, in part, as follows:

There is no immediate danger of a shortage of high-grade ore, even at a production rate of 100 million gross tons a year. Whether exhaustion of high-grade open pit mines occurs in 1950, 1954, or some later date, is a matter of controversy. With proper advance planning, sufficient ore can at all times be produced to take care of all needs likely to arise. But costs are expected to be higher.

Benjamin F. Fairless, president of the United States Steel Corp., was quoted as saying: "I have been hearing dire predictions about iron ore reserves for 27 years, but as far as I can see they have no basis."

Must Use Lower-Grade Bauxite

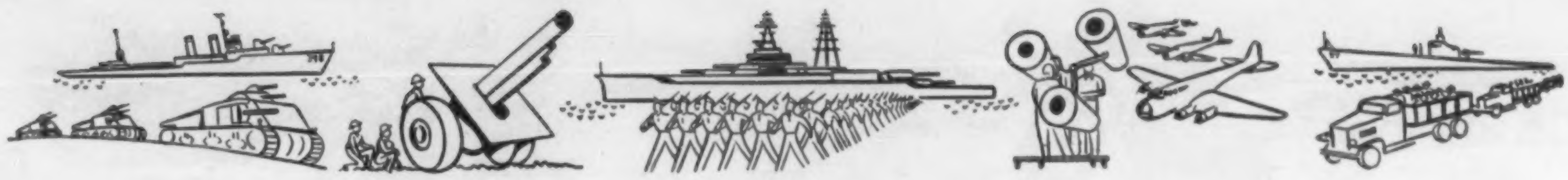
Pointing out that the supply of native high-grade bauxite for aluminum in the United States is limited, Dr.

Alloy Steel in Aircraft

An Aircraft Alloy Steel Section has been set up in the Steel Division, WPB, to help speed deliveries to aircraft plants, headed by Louis E. Creighton, formerly vice president of Rotary Electric Steel Co., Detroit, and previously an executive of Union Drawn Steel Co.

This reminds us of an unpublished "story." Previous conceptions of stratosphere temperatures were a uniform —67 deg. F., whether over hot flying fields of Texas, or arctic Greenland. But this has been disproved. Leaving a temperature of 110 deg. F. on the ground, airplanes have encountered —110 deg. F. in the stratosphere. "Someday it can be told" how metallurgical engineers licked these extreme temperatures. At 110 the alloy steels undergo "creep"; at —110 they gain in tensile strength but lose impact strength. The war could have been lost had these handicaps not been remedied.

Production of alloy steel ingots for aircraft and other wartime uses rose in January to 1,260,000 net tons, a new all-time high—more than 300,000 tons above the 1942 average monthly output. In 1938 it averaged 138,000 tons monthly.



R. S. Dean, assistant director of the Bureau of Mines, has formulated a plan to obtain aluminum from domestic clays, alunite, second-grade bauxite and other alumina-bearing materials.

The program has six practical phases: (1) Further exploration of domestic bauxite to find increased reserves of first-grade; (2) a four-fold increase in exploration for second-grade bauxite for use in first-grade plants being converted to second-grade; (3) construction of a plant to mill high-silica bauxite and produce first-grade bauxite concentrates to supply first-grade plants until they can be converted; (4) construction of plants for production from domestic clays; (5) erect plants to extract alumina from alunite; and (6) continued research in metallurgical and milling problems to assist the entire aluminum industry.

The Real Super-Man

by V. M. McConnell

The Yankee metalworker rose
The day the shooting first began,
And got into his fighting clothes
Like any other fighting man.
And when he stood up straight and mad,
One saw his continental size
And all the mighty plants he had,
And knew that he was metal wise.
He turned out metal, hard and rich,
A hundred million tons or more,
And tougher steel, the like of which
The Heinies never saw before.
They say "The partners" want a truce,
So six professors and a clerk
Can visit us on some excuse—
And catch up on their metal work.

Thoughts on Eberstadt's Dismissal

Part of the lateral oscillation that has developed critical periods of vibration has been taken out of the War Production Board by:

1. The explosive dismissal of Ferdinand Eberstadt and the putting of General Electric's Charles E. Wilson at the helm of production for WPB; and

2. The resignation of Lou Holland from the Smaller War Plants Corp. following the appointment by Donald M. Nelson of Col. Robert W. Johnson as "head." Mr. Nelson then named the Ordnance colonel, who had been assigned to the corporation by the President, a deputy chairman of WPB in place of Mr. Holland.

Mr. Eberstadt, whose star shone brightly in the dimmed-out environs of Wall Street during the ascendency of the Security Exchange Commission, was closely associated with Judge Robert P. Patterson and James V. Forrestal, attorneys, now Under-Secretaries of War and Navy, respectively. He had an important role in the recent reorganization of the Army, working with Under-Secretary Patterson. He was appointed chairman of the Army-Navy Munitions Board, a sleeping giant of power.

But when Mr. Eberstadt and Mr. Wilson were given equal status by Mr. Nelson on assignments that conflicted, Mr. Nelson again demonstrated that he had much to learn about production. The simple fact that a factory's — or nation's — production manager *must* control his flow of materials had entirely missed Mr. Nelson's keen mind.

Since the days of the National Defense Advisory Commission of nearly three years ago, the NDAC itself, OEM, OPM, SPAB, and WPB have been advised by competent industry consultants to set up materials scheduling. But theorists were in the saddle and rode hard.

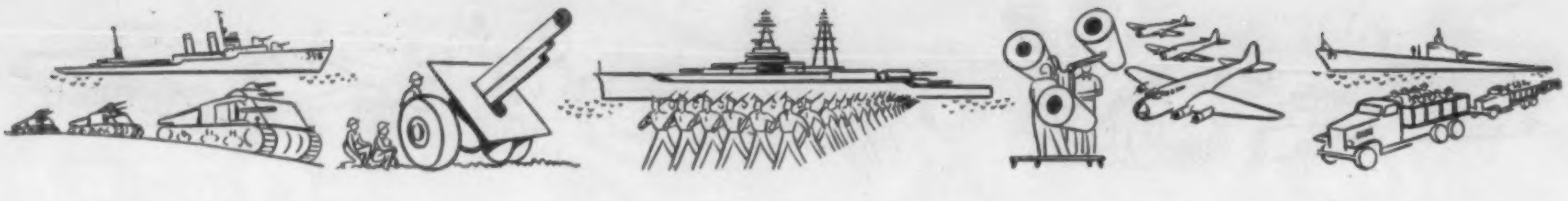
Wilson, a practical production man who had been works manager of small General Electric shops and finally rose — at a very early age — to the corporation's top production executive, is today production manager of the largest manufacturing operation in history as vice-chairman of WPB.

If he is able to establish WPB as a service organization for the Army and Navy, and service the production needs of all procurement agencies, he will establish himself as the Baruch of World War II. If he expects to run the Army and Navy procurement programs, he will have the biggest fight on his hands that Washington has seen since Pearl Harbor. In Washington's press rooms, odds are against his winning.

Mr. Wilson must establish this philosophy of service not only with the military, but with WPB itself. Recent public statements made by Mr. Nelson indicated that this is, in his opinion, WPB's function from here on in. But there are numerous lesser lights who have had no reason to think so during the tumultuous confusion down there these past two years.

Col. Johnson, too, has a great opportunity to become a famous man. The political aspects of the Smaller War Plants Corp. are tremendous to contemplate, despite the fact that Congress appropriated a mere $150,000,000. (The daily rate of war expenditure is about $244,000,000).

He made a name for himself as chief of the New York Ordnance District in respect to spreading war work among smaller shops. He has the first solid groundwork to build upon, thanks to the unsung effort of Mr. Holland, who took the scattered ends of the Old Contract Distribution Division of OPM and WPB and put together a working organization. If



Col. Johnson succeeds, he'll be of cabinet stature, at least.

They Have Faith in CMP

In its original form, the Controlled Materials Plan never had a prayer. Its authors — self-styled — and its ardent supporters were technically illiterate although powerful in the hierarchy of the War Production Board.

The high command, under Charles E. Wilson, is rather remarkable, however, inasmuch as most of it consists of practical production executives who believe that CMP can be made to work — now that revisions are in their hands.

An example of the realism that has superseded theory, Roy Johnson explained to an informal group of automotive executives and METALS AND ALLOYS how WPB planned to schedule critical component parts. It made sense, the men from Detroit agreed. He has been a production executive for General Electric and other metal-working companies, and understands the No. 1 problem of WPB — flow of materials.

Until the position of Mr. Wilson has been "clarified by the emissaries of the White House," he will be unable to do a job. The lexicographer's nightmare "resolve" (five inches in Webster's unabridged) has again reared its fuzzy pate in this connection, although Curtis E. Calder, Mr. Wilson's director general for operations, is busy with his staff on simplifying the CMP procedure. "The whole WPB setup is being resolved in the White House," one WPB spokesman told METALS AND ALLOYS at press time.

But Mr. Calder's announced elimination of the form CMP-6, which was to have been filed with all purchase orders for controlled materials, will save 12,000,000 pieces of paper during the first six months.

Tomorrow's Problem Tougher Than Today's

Although many old-line military officers resent current kudos to industrial production executives, those who understand manufacturing are enthusiastic in their praise of American industry's "impossible" achievements.

At a recent staff conference of the Tank-Automotive Center in Detroit, Maj.-Gen. Levin H. Campbell, Jr., chief of the Army's Ordnance Department, introduced Lt.-Gen. Jacob L. Devers, chief of the Armored Forces, and Brig.-Gen. G. M. Barnes, chief of the Technical Division, Ordnance Department. Both of these officers had just returned from North Africa, where they saw industry-made tanks, armored cars, artillery and ammunition in action. Both agreed with General Campbell that the cooperation of industry and the Army is an important factor in spelling out the doom of the Axis.

Significant is General Campbell's attitude, as expressed by him:

"I don't mind telling Hitler that we're never satisfied, and out of this conference between industry, the Armored Forces, and our technicians will come still more effective weapons to insure the ultimate victory of the United Nations."

He won't, of course, tell Hitler or Hitler's technicians details of how industrial engineers, now in service for their Government as temporary officers and engineering executives in their own plants, are doing it. That will be the dramatic homefront chapter of the history of World War II when it can be told. This is a chapter of minutia: Chemical compositions of alloys, slight changes in redesign of fighting equipment to permit substitution, and all in all a degree of ingenuity that would make Jules Verne hang his imaginative head in shame.

If top military command is to be credited, this will be a long, hard war to win. That means that we're only beginning. But the solidity of the stepping stones is encouraging — if adulation is not taken too seriously. Tomorrow's engineering, metallurgical, chemical and manufacturing problems will be tougher than today's, they told METALS AND ALLOYS in both Washington and Detroit.

Evolution of the Machine Tool

"In the last war, much work that required extreme accuracy had to be finished by hand. With the increased precision of today's machines, this is seldom necessary. This is another reason why war contractors are so desirous of obtaining new machine tools in preference to using their old machines," states the February publication of the *National Machine Tool Builders Association*.

"Since World War I, machine-tool design has tended constantly to take more of the physical effort away from the operator and make the machine do the work — the operator providing the guiding intelligence. Today, little actual physical strength is needed. There are levers, controls, buttons and measurements to be taken carefully with gages and micrometers. The operator uses brains rather than brawn, and thus women can run many machine tools as well as men."

The bulletin also suggests that by now the country is pretty well saturated with tools. "Some companies will find demand falling below capacity," it states. In this connection, Charles J. Stillwell, president, Warner & Swasey Co., Cleveland, machine tool builder, wrote to stockholders: "If it should develop that the demand for turret lathes is not sufficient to utilize our full production facilities, we shall endeavor to undertake the manufacture of other items."

What's Ahead in 1943?

Highest authorities tell us at press time that the solution of all our main war-production problems is in sight. Now within 75 per cent of our desired production rate, the problem next Fall may be to keep war plants fully occupied because of contract completions in some lines (except airplanes and escort vessels).

Therefore, Fall may see a shift of some war production to civilian production. Many believe the manpower problem—possibly less formidable than it seems—will be solved as readily as that of materials and components. Right now the greatest hurdle to jump is shipping—and it *is* serious!

Feature Section

Silicon Bronze Castings

Foundry practice for making silicon bronze castings becomes an increasingly important topic as the tin situation continues to tighten. Portman (page 528) describes foundry technique for silicon bronze using high-frequency induction furnaces as the melting medium.

Rectifiers vs Motor Generators for Plating

Reinken (page 533) discusses the use of the rectifier as a source of d.c. power for electroplating and other uses, and makes some comparisons with the motor-generator.

Carbide Dies for Steel Shell Cases

The switch from brass to steel for shell cases has tremendously increased the use of carbide dies for drawing the metal. Glen (page 536) gives practical suggestions for servicing the dies in users' plants.

Manganese "Stainless"

Part II (the concluding section) of Parks's presentation (page 539) of the properties of chromium-manganese stainless irons and steels gives data on cold-working tendencies, tensile properties and corrosion resistance.

How the British Save Tin

Ireland's second article (page 544) on tin conservation in Britain tells how our English allies save tin in solders, babbitts, bronzes and protective coatings.

Glass Gages Instead of Steel

The advantages of glass to replace steel as the material for precision gages are well brought out in a description by Hambleton (page 548) of the growing use of glass gages in ordnance inspection.

"File Facts" for March

Four pages of Engineering File Facts are offered this month — for materials and design engineers, a page (page 554) comparing steels in various forms, and another (page 559) of hardenability data; and for production men a 2-page summary of welding processes starting on page 555.

Metallurgical Engineering Digests

Remelting Cartridge Cases

American metallurgical engineers concerned with the problem of remelting fired brass cartridge cases will be interested in British experience in using such scrap, reported in *Metallurgia* (page 568).

Magnesium Foundry Practice

Useful hints for the manufacture of high-quality magnesium alloy sand castings are presented by Ladhams (page 576).

Carbide Tools in Germany

The British magazine *Automobile Engineer* (page 584) has published a translation of a recent German monograph on the properties of and methods of handling carbide tools in Germany. Some interesting comparisons with U. S. practice can be made.

"Stop-Offs" in Carburizing

A group of familiar "stop-off" materials and practices is discussed by Thompson (page 608), and the effectiveness of electroplated copper compared experimentally with other means. (The plated copper wins hands down!)

Ceramics as Alternate Materials

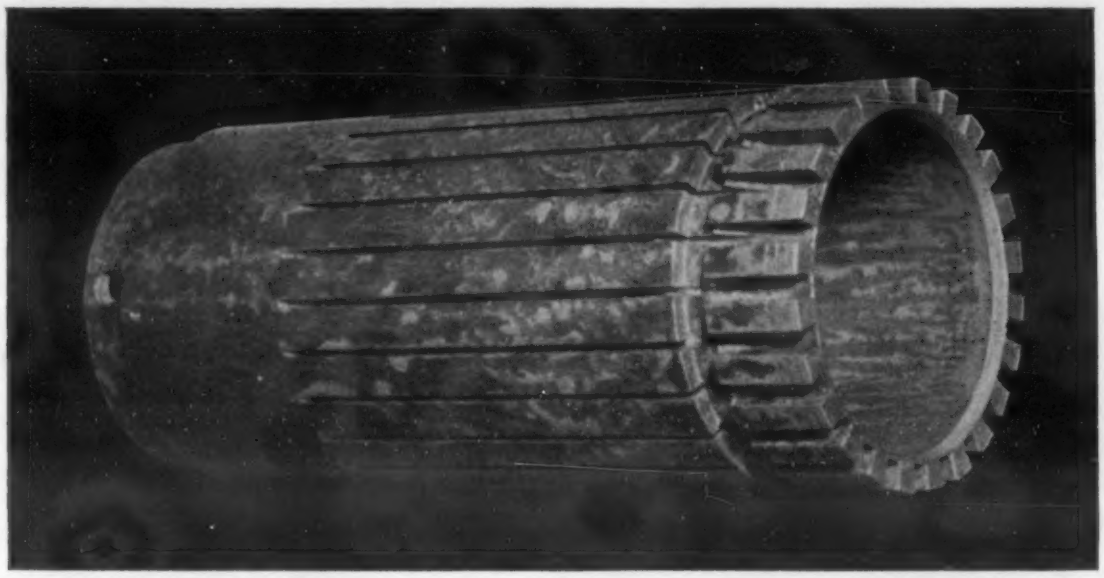
A broad, useful review by *Modern Industry*, (page 622) of the use of ceramics as substitutes shows that porcelain and other ceramic materials are replacing metals, rubber and plastics for a host of war-useful parts.

Attack of Metals by Mercury

The effect of mercury on the metals with which it necessarily comes in contact in telephone and electrical equipment is reported by Prescott (page 626).

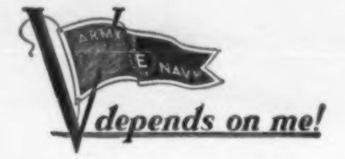
Radiography in the Foundry

The general aspects of employing X-ray inspection for control of castings-manufacture and for other foundry purposes are outlined by Montgomery (page 642).



Typical part of the "munitions that make the munitions" is this cylinder head for a Fidelity Sinfra Triple-Head wire-covering machine. It's of chromium steel, and is shown here just after Vapocarb-Hump Hardening and Homo Tempering.

A SLOGAN FOR ALL AMERICANS



ON THE "HEAT-TREAT" FRONT This Cylinder Shows The Way

Prevention of warp, scaling and pitting, in the heat-treatment of intricate war-production parts technically like this cylinder, is of course nothing new to the Fidelity Machine Co., Philadelphia. The types of steel, the methods of grain-refining, machining, heating, quenching and drawing, and other factors which influence heat-treatment have always had skillful attention, and heat-treatment results have been excellent. Never, however, have good results been attained with so few rejects as since the Company turned to the Vapocarb-Hump Method for hardening, and Homo for tempering.

One feature of the equipment which contributes important war-time advantages is that the Vapocarb-Hump Method controls the rate at which the work is heated, as well as the furnace temperature. To do this, the equipment's Micromax Pyrometer first shows the heat-treater what difference in temperature he will get, between the work and the furnace, for any heat-input he selects. Then, when he has selected the difference he thinks best, the Micromax holds it, automatically. Work goes up to the critical, through it, and on to the quenching point, with no overheating; hence no unexpected warp.

The second Vapocarb-Hump feature which figures in Fidelity's success in hardening is that the furnace's high-purity, closely-controlled atmosphere protects the charge against scaling. Cylinders and other parts are as smooth when they leave for the quench as when they reach the furnace. Rejects for surface imperfections are negligible.

Tempering is less spectacular than hardening, but a full share of Fidelity's success in heat-treating is attributed to their Homo - Tempering equipment. The Homo brings the parts up to the exactly desired tempering point, and holds them there, with no over-heating and no falling away. Parts receive the exactly-specified temper; rejects due to tempering are now unknown.

Vapocarb-Hump Hardening is described in Catalog T-621 and Homo-Tempering in T-625; either or both will be sent on request. If you have a specific heat-treating problem, we will be glad to give specific engineering service on it.

Placing a knitting-machine cylinder in one of the Vapocarb-Hump Hardening Furnaces in Fidelity Machine Co's heat-treat department. Note convenience and accessibility of furnace interior.

JRL AD T-620(16)

LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Those Scrap Exports to Japan

During the last ten years of our commercial relations with Japan the United States exported about 10,000,000 tons of steel scrap to that country. Ever since Pearl Harbor it is a quite popular pastime to speculate on how we would stand, steel economically speaking,—and how would Japan—had that valuable ferrous material never been sent.

For instance, Robert W. Wolcott, president, Lukens Steel Co., who had long been identified with a movement to limit such exports, now asks the question whether we would have had to build up 20,000,000 tons in new pig iron capacity had we kept this scrap at home.

The Business Press Industrial Scrap Committee suggests that perhaps these scrap shipments actually did the Japanese harm since they tended to build open-hearth furnaces instead of blast furnaces. Now, with U. S. scrap cut off, they need blast furnaces which are not there because they seemed unnecessary.

This suggests, too, that Japan would be farther along in developing the iron ore resources of Japan, Korea and Manchuria and perhaps would have accumulated large stocks of ore from China, Malaya and the Philippines. Apparently the last pig iron production figures for Japan are 1935 when the output was 2,758,803 tons. Undoubtedly this production is considerably higher today to jibe with her supposed steel production of 8,000,000 tons yearly.

But finally, as regards those scrap exports to Japan—theoretically the 10,000,000 tons has acted doubly against the United States. Actually, it might be said to be equivalent to 20,000,000 tons lost to the United States. Not only have we been minus that amount of scrap, usually the preferred grades, but the same scrap has been used against us—shot at us as shells, bombs, torpedoes.

—H.A.K.

Machining Can be Engineered, Too!

Once upon a time there was a superintendent of a very large machine shop who had worked himself up from an apprenticeship to his present lofty eminence in no less than 30 years. As he was an able mechanic and hard-driving boss, his shop was a very well-operated shop, indeed. Working along more or less standardized lines he managed to manufacture a respectable volume of nicely-priced machine components every month, paid his boys and himself well and provided a comfortable margin of profit for the stockholders.

Now so far this seems like a hum-drum yarn—the usual American story of the gifted mechanic who becomes a key man in somebody's business, without benefit of engineering training and without benefit of an engineering staff. The story takes a sudden and violent turn (as do the hundreds of identical true stories one could write about other shops all over the country) when war production moved in and the "traditional" practices, the cut-and-try set-ups and the familiar disdain of the new and "scientific" were found completely inadequate to cope with the strange problems that arose.

These problems stemmed from three basic circumstances—the shortage of skilled machinists, the scarcity of tungsten, molybdenum and other alloys for cutting tools and the disconcerting pressure for ever-increasing production. Engineers were brought in, assigned to the problems, and solved them in short order. They also corrected several inefficient technical practices that came to their attention incidentally. The engineers are staying on, their number has increased and one of them is now the ex-superintendent's boss.

In countless plants, machining has joined the list of processes that have come under engineering control, to stay there permanently. Hans Ernst and M. E. Merchant in their article in our January issue mention some of the results of this trend—a swing to automatic machines in plants that had shunned them before; the increased use of *tipped* high-speed tools and the expanded use of carbide tools for machining steel; new and heavy emphasis on tool design and finish; new surface treatments for better tool life; the use of more efficient cutting fluids and coolant temperatures, etc.

Metal-cutting, these authors conclude, is gradually developing from the art to the science, "with engineering principles playing an increasingly important part in practical machining operations." Another old-line fortress is tottering before the relentless advance of engineering control! —F.P.P.

Competition of Materials

Doubtless one of the most frequent causes for brow-knitting during the meditative moments of industrialists is as to what extent "alternate" materials will become the primary materials when peace comes. Will plastic doorknobs usurp once and for all the brass counterparts of a by-gone era? Will silver contact points in the consumer telephone equipment throw copper permanently out of the picture?

One thing we may be sure of. The present is no criterion of normal times. All supply and demand is out of balance, and with great distortion. Costs, practicability, man-hours needed for manufacture and all such considerations of normal times have no weight in the present struggle for the nation's survival. Materials are not truly competing with one another now. The chemical vat made of ceramics is not actually competing with the container made of stainless steel.

But, of course, an era of terrific competition is on the way, and it will come shortly after Hitler goes the way of all too-ambitious and ruthless dictators. If we are to remain philosophical, we must be cognizant of two fundamental truths. The first is that a truly useful material always survives. Copper and bronze were found in the tombs of the ancient Egyptian kings. If they have survived so many centuries, they should be able to eke out a few more.

Second, the present has taught industrialists the tricks of speedy and successful "conversion." Thus, conversion that was used in war can be applied to peace. Let the industrialist keep his ear to the ground both before and after peace comes, and be ready, perhaps, to switch some of his products at the right moment to the new lines of materials that give promise of being permanent.

For instance, the sixth largest steel producer

(Editorial continued on page 532)

Silicon Bronze Castings

By ELY PORTMAN
113A. Lexington St., Newport, R. I.

Pouring brass castings in the foundry of the Hobart Mfg. Co., Troy, Ohio (Courtesy: The Austin Co.)

Silicon bronze is perhaps the most important structural bronze available at this time. The scarcity of tin will be more and more evident as the weeks pass, and the necessity for replacing the tin bronzes will be vital.

The melting of silicon bronze, or any other copper alloy, by the high frequency coreless induction furnace presents problems not found in the other standard melting practices, but it has the advantages of speed and ease of atmospheric control.

This article presents the practical problems encountered in working with silicon bronze, both in the foundry and in the machine shop, and describes the use of high frequency furnaces for melting this material. Many of the theoretical aspects have been neglected, since the primary task is to make serviceable castings in the shortest possible time.

THE MELTING EQUIPMENT at the foundry with which the writer is associated consists of Ajax Northrup coreless induction furnaces of the lift-coil type suitable for No. 60 standard crucibles. Rapid melting is obtained; a 180-lb. charge of silicon bronze is brought to the proper temperature in 13 to 14 min. The rolling action of the molten metal, characteristic of induction melting, constantly exposes a fresh surface to the atmosphere, a condition conducive to excessive oxidation and gas absorption unless care is exercised.

Foundry Practice

Albany No. 1 molding sand of AFA 2E classification is being used. One part of new sand is mixed with 10 parts of used sand, with colloidal clay additions being made when necessary. The properties of the mulled sand are as follows:

Moisture, per cent	5.5 to 6.5
AFA Green permeability	18 to 22
AFA Green compressive strength	6 to 8
AFA Clay content, per cent	6 to 10%
AFA Grain fineness No.	145 to 170

Green sand molds are used for smaller castings, and skin-dried molds are used for the larger castings. A sharp sand-linseed oil mixture is used for cores which are baked at 425 to 450 deg. F. for 3 to 8 hrs. depending on their size. The core making is carefully controlled to avoid excessive rigidity, thereby eliminating one of the major causes of cracking in high shrinkage areas of castings.

Chills are liberally applied on heavy sections. Risers are usually cut larger than for gun-metal castings and are designed so that the metal in the riser is the last to solidify. The larger castings are cast between 1900 and 2000 deg. F., and the smaller castings from 2050 to 2150 deg. F.

All physical test specimens were cast in green sand molds as detailed in Fig. 10A, Appendix 2, General Specifications for metals issued by the Navy Department.

Preliminary Melting Results

The foundry's first experimental melt was charged as follows:

Copper	110 lbs.
Silicon-copper hardener	70 lbs.
Zinc	3 lbs.
Tin	1 lb.

The copper and hardener were melted; then the tin and zinc were added just before "power-off." The hardener, which we shall designate as Hardener A, conformed to Federal Specifications QQ-C-581, and had a 10 per cent Si content with the remainder copper.

No cover, charcoal, or flux was used on the melt. The crucible was removed from the furnace when the melt was at 2280 deg. F. The surface dross was skimmed off, and half a pound of 15 per cent phosphor-copper was added. Upon addition of the deoxidizer, a vigorous chemical reaction took place, bringing to the surface a large amount of slag. The slag was skimmed off, and the metal was poured at 2030 deg. F.

The analysis of the bronze and the calculated analysis from the charge are as follows:

	Actual per cent	*Calculated per cent*
Copper	93.48	93.73
Silicon	3.78	3.78
Tin	0.46	0.54
Zinc	1.90	1.62
Iron	0.36	0.16
Phosphorus	0.01	——

The following physical properties were obtained from the test bars cast:

	Actual Test Values	*Navy Specs. 46-B-28*
Tensile strength, p.s.i	35,100-40,000	45,000 min.
Yield strength, p.s.i.	18,600-19,000	——
Elong. in 2 in. per cent	12.5-15.5	15.0 min.
Brinell (500 Kg. 30 sec.)	69.1	——
Fracture	Coarse grain and lack of uniformity in color	

The microstructure as shown in Fig. 1 reveals serious porosity at the grain boundaries, with severe intergranular eutectoid segregation. The first melt of silicon bronze was considered a failure.

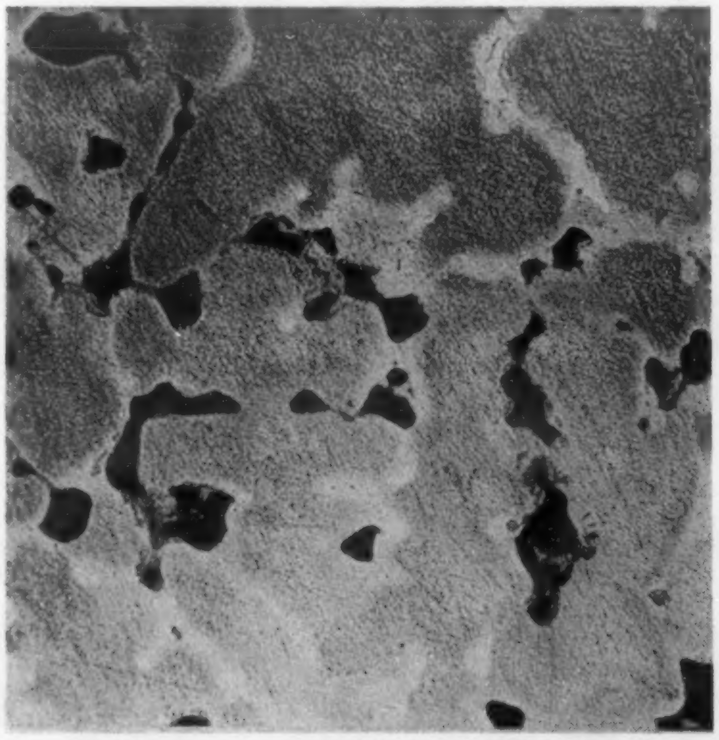
Subsequent Melting Results

Twelve additional melts were cast before a satisfactory product was obtained. Since the 13th was

cast, we have met all physical requirements, and have obtained sound microstructures in our test specimens and castings.

In the first 12 unsuccessful heats we experimented with liquid fluxes (glass, borax, and proprietary mixtures) and charcoal covers. The fluxes and covers were ineffectual since the constant rolling of the metal under the influence of the induction current prevented the formation of an unbroken protective layer.

Fig. 1. Photomicrograph revealing porosity and intergranular segregation. 100X.



The castings were characterized by excessive gas absorption as evidenced by puffing on the sprues and risers upon solidification, by interdendritic shrinkage seen with the naked eye on polished specimens and detailed under the microscope, and by low physical properties resulting from the above conditions. Minor defects were blow holes and dross inclusions.

The first satisfactory melts were obtained by using a hot crucible fitted with a cover, by adding about 2 lbs. of 15 per cent phosphor-copper per 100 lbs. of metal after the melt was removed from the furnace prior to pouring, and by omitting the charcoal and liquid fluxes which were previously used.

Figs. 2 and 3 reveal the structure of the first two successful test bars made with hardener A. The metal in Fig. 2 was poured at 1950 deg. F.; that in Fig. 3, at 1900 deg. F. Note uniformity of grain and absence of porosity.

The physical properties of the test bars cast are as follows:

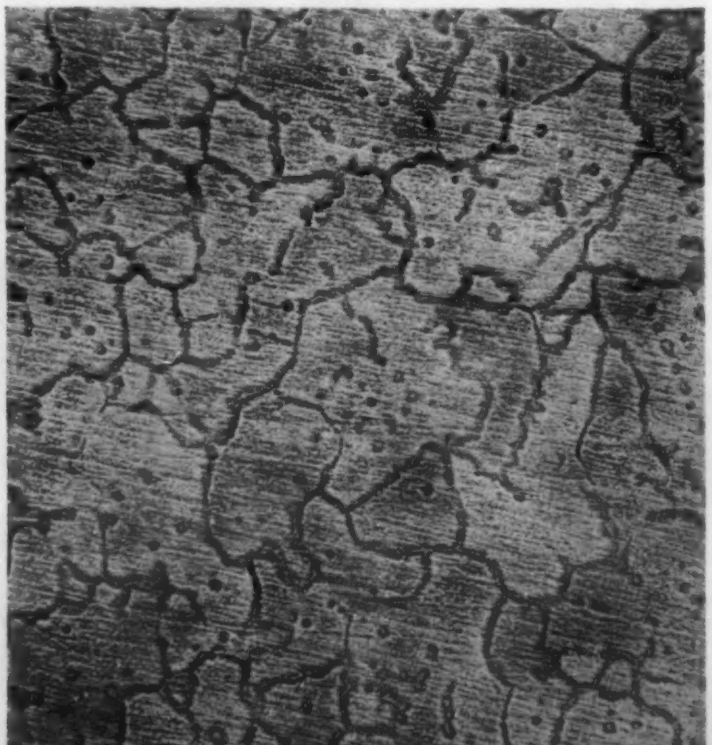
Tensile strength, p.s.i.	48400-51500 p.s.i.
Yield strength, p.s.i.	17470-19900 p.s.i.
Elongation in 2 in. per cent	23-35 per cent
Brinell (500 Kg. 30 sec.)	74-85
Fracture	Fine, uniform grain

Machinability

First reports from the machine shops indicated that the silicon bronze alloy was hard and brittle, and

Fig. 2. Alloy cast at 1950 deg. F. 35X. Etchant: Potassium dichromate and ferric chloride.

Fig. 3. Alloy cast at 1900 deg. F. 35X. Etchant: Potassium dichromate and ferric chloride.



dulled the cutting tools excessively. This difficulty was overcome by reducing the residual phosphorus content of the alloy from 0.30 to 0.15 per cent, and thereby lowering the amount of the extremely hard copper-phosphide constituent. As the melting technique improved through familiarity with the alloy, the phosphor-copper additions were reduced to 1 oz. per 180 lbs. melt with the resultant lowering of residual phosphorus to but a trace without adversely affecting the physical properties and sound structure, and at the same time further improving the machinability of the castings.

Hardeners and Pre-Alloyed Ingots

Experimental melts were cast using a charge of 77 parts of copper, 20 parts of hardener (Cu 70, Si 20, Fe 10 per cent) which we shall call B, and 3 parts of zinc. Varying percentages of scrap derived from this mixture were added to the charges. Sound castings and high physical properties were obtained on all melts including 100 per cent scrap remelts. The average properties and range of 24 tests are shown in the Table under Hardener B.

Additions of scrap and 100 per cent remelts did not lower the high physical properties of the alloy. Wild scrap of unsuccessful melts, when remelted under proper conditions, produced sound castings with excellent tensile properties.

The silicon bronze alloy obtained by use of Hardener A had lower tensile strength, yield strength, and hardness, but higher elongation than the silicon bronze obtained from Hardener B. The average properties and range of nine tests are shown under Hardener A in the Table.

Ingots, the chemical analysis of which conformed to Navy Specifications 46-B-28, were obtained from two commercial sources to determine their suitability for remelting and casting. The ingots are designated as Ingots A and B in the Table, and it is seen that their properties are quite similar to each other. The typical chemical analysis of these ingots are as follows:

	Ingots A per cent	*Ingots B per cent*	*Navy Specs. 46-B-28 per cent*
Copper	90.46	90.94	Remainder
Silicon	4.00	3.91	1.00-5.00
Zinc	4.33	3.56	5.00 max.
Manganese	0.34	0.42	1.50 max.
Iron	0.62	1.17	2.50 max.
Tin	0.25	None	2.00 max.
Phosphorus	Trace	Trace	———

The results of four tests of ingots A, and nine tests of B are included in the Table of physical properties.

The foundry was able to observe three distinct advantages in using pre-alloyed ingots over a charge consisting of hardener, copper, and zinc. These advantages are:

(1) Fewer weighing operations save time and reduce errors in making the furnace charge.

(2) Melting time is lower for a 180-lb. charge by 2 to 3 min.

(3) Less dross forms during the melting.

Table of Properties and Range Using Hardeners and Ingots A and B

Properties	Hardeners				Ingots				Navy Specs. 46-B-28
	A		B		A		B		
	Average	Range	Average	Range	Average	Range	Average	Range	
Tens. Str. in 1000 p.s.i.	50.2	48.4-54.1	60.6	54.3-65	54.1	52.4-55	53.9	47.5-58.5	45 min.
Yield Str. in 1000 p.s.i	17.5	14.5-19.9	26.4	26.3-31.2	25.8	25.5-26.3	25.4	19.8-30.8	......
% Elongation	33.3	23-64	20.7	15.26	16.75	15-18.5	15.9	13-24	15 min.
Brinell Hardness (500 Kg 30 secs.)	78.0	65-86	92.5	86-100	98.0	98-98	91.5	90-93	......

Typical Analysis of Test Bars, per cent

	Hardener A	Hardener B	Ingots A	Ingots B	Navy Specs. 46-B-28
Copper	93.3	91.48	90.47	91.61	Remainder
Silicon	3.2	4.26	4.10	3.20	1.00-5.00
Iron	None	1.72	0.70	1.19	2.5 max.
Manganese	None	None	0.38	0.22	1.5 max.
Zinc	3.5	2.54	4.35	3.78	5.0 max.

Some Special Processing Problems

Difficulty was experienced in soldering silicon bronze castings to steel shells. The gas flame, by oxidizing the silicon at the surface, produced a sandy area over which the lead-tin solder would not spread. This condition was remedied by immersing the castings in 5 per cent hydrofluoric acid, at room temperature, for 3 to 5 min. before the soldering operation.

Some difficulty was encountered by the accidental mixing of scrap silicon bronze with gun-metal scrap. Gates, sprues, and risers would find their way into the wrong scrap heap, and finally into the melting pot where the melt would be rendered useless.

A quick spot test was devised for the identification of the scrap metal. For the test, one drop of 1-1 nitric acid is placed on the cool sand blasted, machined, or ground surface of the metal. Gun metal is identified by a light blue coloration, and silicon bronze is distinguished by a dark coloration with a blue-black border. This acid test has saved many melts from contamination.

Using ingots and hardener from four suppliers, we have poured thousands of satisfactory castings ranging in weight from 1 to 80 lbs., the average weight being about 30 lbs. per casting. The sprues, gates, and risers originally used on the same castings made of gun-metal had to be altered in many cases to provide for the higher shrinkage and greater fluidity of the silicon bronze. We have found that all turbulence in the metal as it is filling the mold must be eliminated by strainer cores, by-pass gates, and slow pouring; and that the castings must be properly fed by gates and risers to eliminate shrinkage cavities.

Some trouble was experienced with castings in which there were abrupt changes in section thickness. Chills and generous fillets were provided to obtain a proper temperature gradient during the solidification.

The production castings have withstood hydraulic pressure tests up to 300 lbs. per sq. in. and air pressure tests up to 95 lbs. per sq. in. These were regular production tests and are not to be considered the maximum pressures that the castings could withstand.

Corrosion

In view of the fact that some of our bronze castings are joined to steel, and the assembled parts are often submersed in sea water, a study of the contact corrosion was made. The relative susceptibility of steel to corrode when in contact with silicon bronze and gun-metal was judged by measuring the electrolytic potentials in a 3 per cent sodium chloride solution. The potentials across the various cells were as follows:

Bronze Alloy	*Corroding Member*	*Volts*
Silicon bronze from Hardener A	Low carbon steel	0.404
Silicon bronze from Hardener B	Low carbon steel	0.392
Gun-metal	Low carbon steel	0.417
Silicon bronze from Hardener A	SAE 4340	0.285
Silicon bronze from Hardener B	SAE 4340	0.227
Gun-metal	SAE 4340	0.256

From the test results it is evident that there is little difference in the corrosion properties of the three alloys. Silicon bronze obtained from Hardener B appears to be the least corroding of the three.

Summary

This report presents the major details of one foundry's experience with silicon bronze. There have been disappointments and difficulties, but now we are in full scale production with silicon bronze, and there is doubt that we will ever go back to gun-metal even when the supply of tin becomes more ample after the war is over.

Sound castings with high physical properties can be obtained either by use of hardeners, or simply by remelting ready-alloyed ingots. The choice of method for obtaining silicon bronze depends on the properties desired, comparative cost, and ease of charging and melting.

High frequency induction melting offers no serious difficulties once the proper technique has been established. It must be emphasized, however, that for consistently good results it is highly important to charge the metal in a hot crucible fitted with a cover.

Clean, pressure-tight castings demand good foundry practice. Proper gating, adequate feeding, avoidance of turbulence, and slow pouring are all essential.

(Editorial continued from page 527)

has, under war necessity, changed one department into the manufacture of wooden pipe in the place of steel. Perhaps such diversification might well be quite general when peace comes —or, at least, until the competition of materials under normal peace conditions has weeded out the upstarts from the durables.

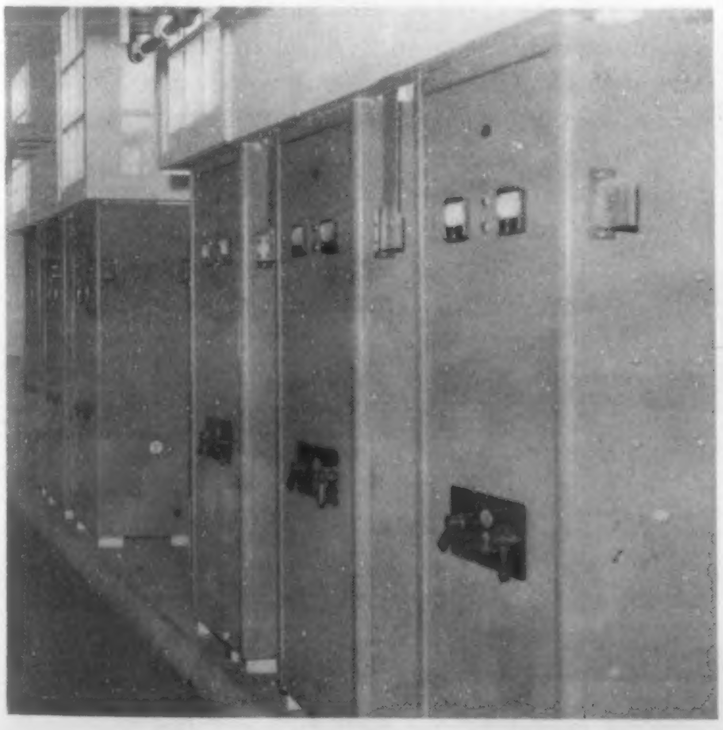
In time, all materials will find their true level. The round pegs will eventually find the round holes. The sooner the correct material is adopted for any specific purpose and prices are adjusted to correct relationships, the better for the general public—and, hence, for the manufacturer. —H. A. K.

One of the most interesting trends in recent years has been the rapid growth in the use of rectifiers for supplying the necessary direct current for electroplating, anodizing, electrolytic refining, electrocleaning and other uses. The rectifier has certain advantages that make it more attractive for many jobs, particularly under today's conditions, than the D. C. motor generator. In this article Mr. Reinken discusses the advantages of the rectifier, and compares it from several engineering standpoints with the motor generator, using the electroplating application as a typical case. If proponents of the motor generator for such work feel their favorite has been inadequately presented, we hope they will send us equally factual material for future publication.—The Editors

Why Use Rectifiers for Plating?

by L. W. REINKEN

Chief Engineer, W. Green Electric Co., Inc., New York



A 6-unit rectifier bank installation used in conjunction with a full automatic plating machine.

What do you do when you are required to select new equipment for your plant? If you do as most engineers do, you base your choice on the standard practice prevailing in your particular industry. This conservatism is usually sound because "standard practice" has evolved from the experience of your many predecessors who determined, by trial and error, which of the several alternatives originally available were preferable. It would appear logical that if you follow the procedure used by many others in your industry you cannot go very far wrong.

However, from the standpoint of most rapid technical progress the weakness in the "standard practice" policy is the unassailable fact that standard practice must necessarily be some years behind the introduction of new equipment or methods. In fact, if all the individuals who are responsible for determining what equipments and methods shall be used in our industrial plants persistently refused to use any equipment or method which had *not* been proven in practice, there would never be any further technical progress. Fortunately for industry, there is always a certain percentage of individuals who are willing to try new equipment or methods which, in their opinion, offers merit. Furthermore, there are sometimes circumstances which compel the naturally conservative to change over whether they like it or not.

As all engineers and industrialists know, war is one of the most potent factors in accelerating technical progress. The need for tremendously increased production, change-over from one type of product to another, shortages of accustomed materials and equipment — all of these force even the most conservative of us to rely more upon our judgment than upon our textbooks.

Rectifiers and Motor Generators

All of this leads up to the fact that the motor generator, which in many industrial fields was considered to be the only practicable source of DC power, now has a very important rival. This rival is the metal rectifier. Particularly in the plating field, (which includes also such allied processes as electrocleaning, electropolishing, descaling, anodizing, etc.) rectifier equipments of all types and sizes have come into widespread use during the last few years.

The first rectifiers introduced were modest in size, built to deliver about 300 amp. at 6 volts. At the present time it is no uncommon thing to see single rectifiers with outputs of 3,000 amps. or banks of such units with outputs of 10,000 and 20,000 amps.

Although rectifier equipments have been introduced on a wide scale chiefly in the electroplating and metal finishing field, there is no technical reason why they cannot be used in other industrial applications where the motor generator used to be considered standard. The purpose of this article is to

provide some comparative data which may be used as a basis for beginning a study of the comparative merits of rectifier and generator equipment for any particular application.

It should be explained that the writer, who specializes in the design of rectifier equipment, is quite naturally an enthusiast on the subject of rectifiers. In the normal course of events he would be content to let rectifiers reach their ultimate place in industry by the natural process of evolution. However, the urgency of the war program, and particularly the drastic shortage of motor generator equipment, makes it necessary to speak loudly and clearly of the merits of rectifiers.

It should also be understood that in the writer's opinion motor generators are, for some applications, still the superior of any other form of DC supply now available. And, as a matter of fact, the features and performance of motor generator equipment are now so well known that most of this article will be devoted chiefly to discussion of metal rectifier equipment, with particular reference to conservation of materials, power, and man-hours.

Rectifier Equipment—Construction

The basic element of any rectifier equipment is the rectifier itself. There are several types of metal rectifiers, of which the better known are:

Magnesium-copper sulphide	Copper oxide (plate)
Lead-copper oxide	Selenium

These are made in the form of discs which are assembled, together with connection terminals, and in some cases also radiating fins, to form units known as "stacks." For some types of rectifiers considerable pressure is maintained on the discs in the final stack form; for other types only comparatively light pressure is required for good electrical contact. (High pressure is required for the magnesium-copper sulphide and lead-copper oxide; and moderate or light pressure for copper oxide *plate* and selenium types.)

In the exceptional case where the required DC voltage is comparable to the available AC line voltage (3-phase), it is possible to build a rectifier equipment consisting of rectifier stacks only. In most cases, however, a transformer will be needed to produce the correct AC input to the rectifier stacks for the desired DC voltage. For DC outputs of over 1 kw, fan cooling is generally used to maintain the groups of rectifier stacks at suitable temperature.

In general, the simplest industrial rectifier equipment comprises basically:

Transformer Rectifier stacks Fan(s) Housing
On-off device (switch, circuit breaker, or contactor, etc.)

To this may be added whatever controls or indicating devices are justified by the application. Examples:

Voltmeter, ammeter
Voltage control (tapped transformers or reactors and selector switches)
or:
Continuously variable voltage control transformer, manually or motor controlled.
Automatic overload warning and cut-off devices
Remote or semi-remote controls
Supervisory lamps, etc.

Complete equipments are generally housed in light gage welded or bolted sheet steel cabinets which, for economy in floor space, are usually taller than they are wide. Some types are mounted on heavy duty roller bearing casters for mobility and simple installation.

Most rectifier equipments are complete units incorporating all auxiliaries such as start-stop devices, voltage control systems, meters, etc. This reduces installation wiring to the absolute minimum.

Rectifier Capacity

A unique advantage of rectifier equipment is that individual units may be connected in parallel or series to obtain greater current capacity or higher voltage. Any number of units may be so interconnected, without loss in efficiency or performance. Most rectifiers are fool-proof against any possibility of backfire or interaction whether all or only a number of the units are simultaneously energized.

There is no technical limitation to the size or electrical capacity of metal rectifier units. However, since rectifier units, unlike generators, may easily be interconnected on site, the maximum size of individual units is based primarily on considerations of ease of manufacture, shipping, and simplicity of installation. Furthermore, large installations made up of a number of units provide flexibility for the future. Such installations may be separated at any time into their individual units which may then be used separately, or, the units may be rearranged to provide a different voltage and current capacity.

By the same token, original rectifier installations may be expanded in current or voltage capacity by connecting additional units in parallel or series.

One typical line of rectifier equipments is available in sizes up to a maximum capacity of 20-30 kw. DC. The physical size and cost of metal rectifier equipments is determined by the kw. output and is substantially independent of the DC output voltage for which it is designed. Thus, the 30 kw. unit referred to might be 6 volts 5000 amp., 12 volts 2500 amp., 24 volts 1250 amp., ... 120 volts 250 amp., 240 volts 125 amp., etc., and in each case would be about the same size and cost.

Electroplating

Heavy duty rectifiers were first applied to electroplating which requires substantial quantities of DC power at low voltages and high currents. There is

a considerable body of experience available from this field and therefore the following data are taken from typical electroplating motor generator sets and comparable (selenium) rectifier equipments.

Motor Generator Sets

A typical motor generator group for an output of 6 volts 3000 amp., includes a 30 or 40 h.p. motor directly coupled to a generator (25 or 40 deg. C. rise), exciter (direct-coupled or separate), ammeter shunt and control panel. The control panel usually incorporates the motor starting devices, meters, generator field rheostat, pilot lamp, etc.

The "25 deg. C." motor generator has a greater overload capacity (usually 25 per cent for 2 hrs.) than the "40 deg. C." set. It is somewhat larger and heavier than the 40 deg. C. type but is preferred because of its overload capacity. (It is believed that the 25 deg. C. units are out for the duration under Limitation Order L-221.)

The motor generator is mounted on a heavy welded-steel frame, and if a direct-connected exciter is included the frame must also provide support for this unit. The generator shaft is necessarily horizontal and the general shape of the unit is longer than it is high. The control panel is usually located near the generator, and a protective fence or railing encloses the floor area allocated to the group.

Motor Generator—Weight and Size

For a 25 deg. C. motor generator (set only) of the type described above, typical dimensional figures are:

Length — 8 ft. Width — 3 ft. Floor area — 24 sq. ft.
Height — 3-4 ft. Weight — Approx. 4500 lbs.

To this must be added the control panel, which may weigh a couple of hundred pounds.

A typical layout of a motor generator set and control panel would require a space allocation of approximately 120 sq. ft. (10 ft. by 12 ft.).

Rectifier—Weight and Size

A comparable rectifier equipment rated at 6 volts 3000 amp. (plus 25 per cent overload capacity) would be housed in a cabinet measuring:

Width — 36 in. Depth — 24 in. Floor area — 6 sq. ft.
Height — 81 in. Weight — 1700 to 1900 lbs.

Since all control and indicating equipment are housed in the rectifier cabinet, no provision need be made for auxiliary equipment. Furthermore, since all live surfaces are internally protected, and all moving parts (fans) are likewise enclosed, there is no vital need for fencing in a restricted area.

Efficiency

Motor generators are usually designed for peak efficiency at rated full load. As the load is reduced efficiency goes down fairly rapidly, because no-load consumption involves not only purely electrical losses but also friction and windage.

Well-designed rectifier equipment has an efficiency at rated full capacity comparable to the motor generator. However, as the load is reduced efficiency goes *up,* and may reach its maximum value (higher than full load efficiency) at about half load. The efficiency then decreases slowly as load is reduced, reaching the initial full load value at 10 to 20 per cent of full load. Hence, efficiency is *maintained* over a load range from about 15 per cent up to full load capacity.

Power Factor and Consumption

Rectifier equipment, at full load, has a power factor of about 0.92 to 0.98, and therefore does not abnormally increase the burden on plant wiring. Some types of motor generators are deliberately designed to help compensate for poor power factor in other equipment in the plant.

Rectifier equipment may be started and stopped instantaneously even under full load, and, of course, there is no heavy starting current or delay while coming up to speed. Even the comparatively small power consumed at no-load may be eliminated by shutting down rectifier equipment during tank loading periods.

In electroplating or other processes which may require several different voltages at different tanks, it has been customary to use one or two large generators with dropping resistors (tank rheostats) to secure the various potentials. The simplicity and compactness of rectifier equipment make it practical to use individual units for each load, adjusting the power supply unit to deliver the required voltage. This completely eliminates any resistance controls in the DC output leads, and also the power customarily wasted in these devices.

Summary

1. The rectifier equipment uses approximately 40 per cent of the metals in a motor generator of equivalent capacity.

2. The rectifier equipment requires only approximately 10 per cent of factory floor area as compared to a motor generator set.

3. Reduced weight, and the use of integral caster mounting, reduces installation man-hours and cost to the absolute minimum.

4. The same factors accounting for simple installation also make the rectifier equipment easy to shift for revised layouts.

5. The rectifier equipment consumes less power than a motor-generator set of equivalent output for several reasons:

(a) Instantaneous start-and-stop permitting shutdown between loads.
(b) Maintained efficiency, even at low loads.
(c) In electroplating and allied processes, the use of individual units permits the eliminating of tank rheostats and rheostat power loss.

Carbide Dies for Steel Shell Cases

—Their Servicing

The manufacture of steel shell cases, now the major concern of a large group of manufacturers, depends for its success on a number of factors. Not the least of these is the nature and servicing of the drawing dies used. In this article Mr. Glen describes in some detail the operating characteristics of cemented carbide dies for this work and the correct servicing practice to obtain high shell-case production and maximum die life, together with satisfactory case quality. The switch to steel shell cases from brass has brought many manufacturers into contact with carbide dies for the first time, and this article will be of especial utility to them.—The Editors.

by EARL GLEN

Carboloy Co., Inc., Detroit

WITH THE CONVERSION from brass to steel for shell cases ranging from 20 mm. up to 90 and 105 mm., the use of cemented carbide drawing dies has now become standard accepted practice. Carbide dies were of course being extensively used for drawing brass cases due to their longer life and lower cost per piece produced. However, with the advent of steel shell cases, carbide dies became a necessity.

It is almost impossible to obtain reasonable steel case production without cemented carbide drawing dies. Conversely, therefore, the intensive and extensive development of carbide drawing dies has made possible the substitution of steel for brass, with attendant large scale conservation of critical materials, particularly copper. According to U. S. Army Ordnance, for example, the saving on a single contract for 105 mm. shell totals 12,600 tons of critical brass.

The conversion from brass to steel did not present any unusual die manufacturing problems since the carbide dies used (Fig. 1) did not differ a great deal fundamentally from carbide dies used in drawing steel tubing. They have been used for such purposes for several years with great success.

The prime difference between most shell case drawing dies and steel tube drawing dies is the provision of a guide ring plate on the former to guide the case into the die. When drawing steel tubing, the end of the tube is pointed so as to feed readily into the die without requiring a guide. In some instances of shell case drawing, moreover, rotary indexing tables are used, eliminating need for the guide ring.

As with any new application of a product, minor service difficulties are to be expected if the user is not acquainted with the characteristics of carbide dies and the proper scheduling and procedure for die maintenance. This is particularly important in view of the fact that quite a few organizations now switching to carbide dies for shell case drawing have had little or no experience with carbides in the past.

Service Requirements

It is absolutely essential that large-scale users of carbide dies, as for shell or case drawing, be in a position to service and re-cut such dies. Carbide dies will produce several times the number of cases between servicing operations that are possible with dies of other materials. It is however necessary that

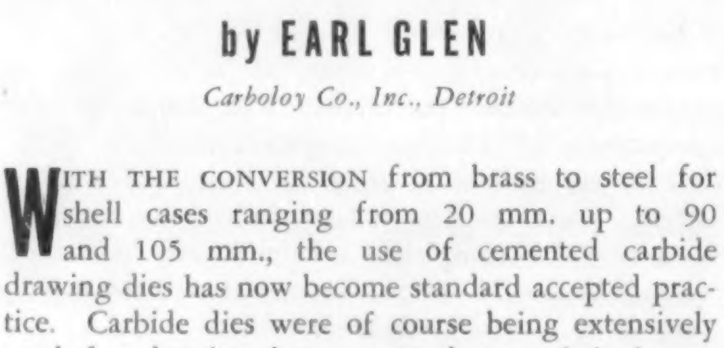


Fig. 1

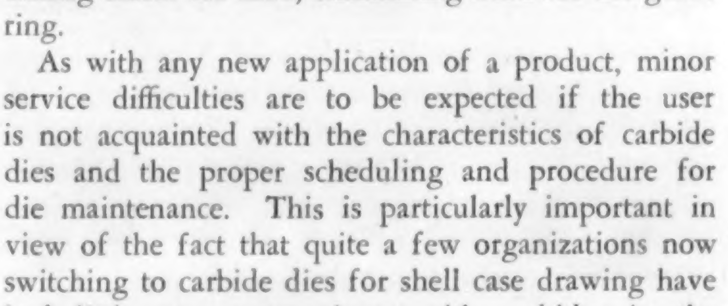
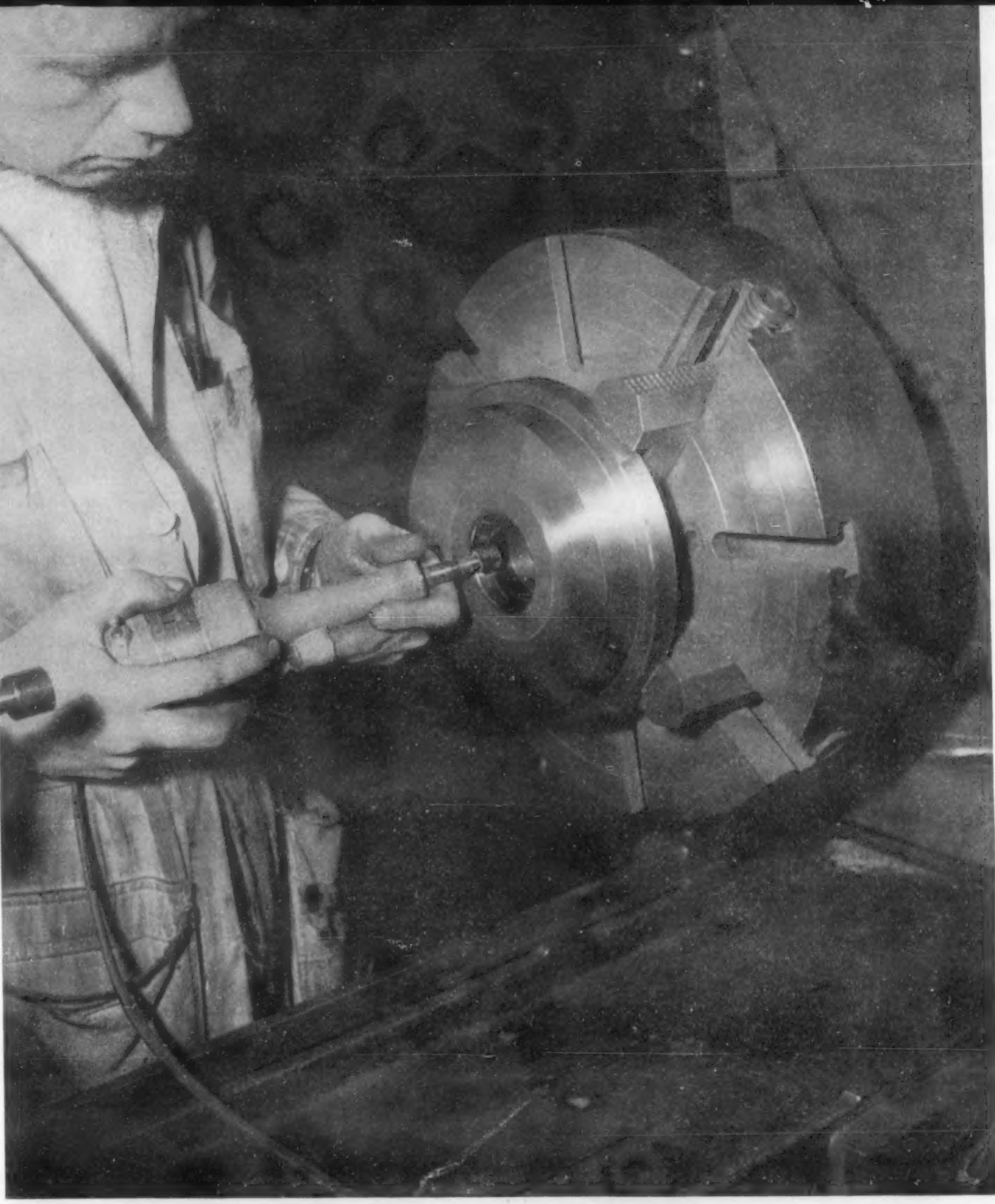


Fig. 2

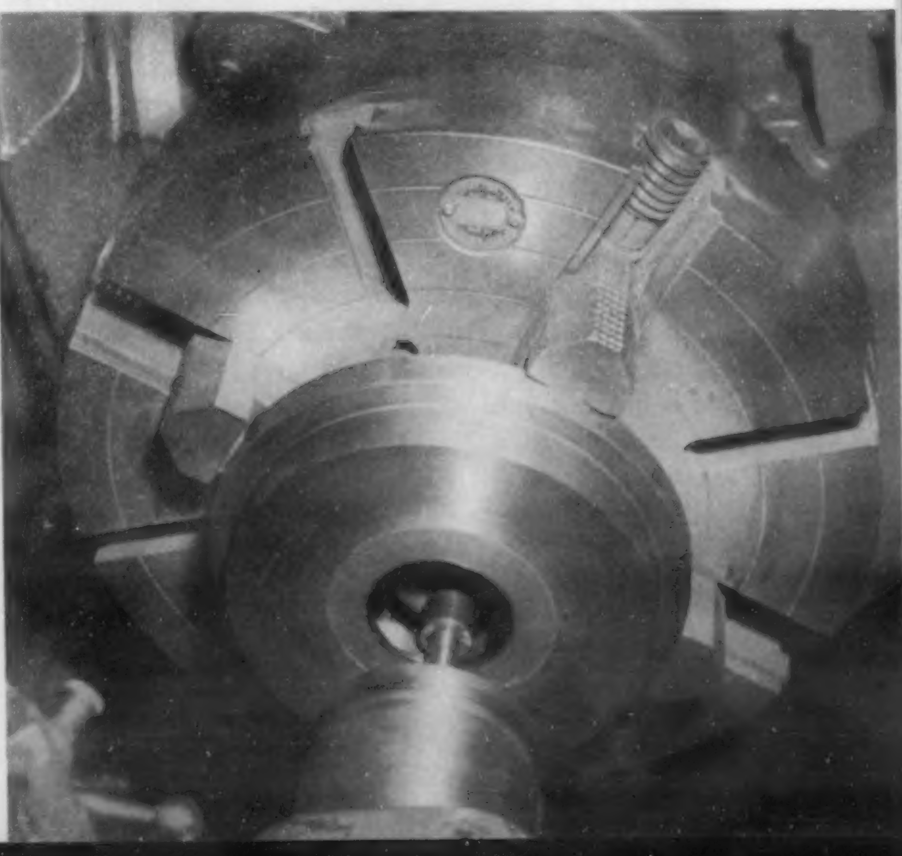


The surface of the die is polished with a felt wheel in the flexible shaft or hand grinder.

they be serviced whenever a "wear-ring" appears in the die nib. In order to maintain continuous operation without an excessive stock of dies, which in turn involves the problem of materials conservation, the necessary simple equipment for both polishing and re-cutting of dies should be provided at the point of use. It has been found also that when dies are not serviced by the user, there is a tendency to let them run longer on a job than they should for most satisfactory performance both as to die life and continuous production quality.

One reason for this is an innate characteristic of all carbide materials. A shell case, when it enters the die, presents a relatively sharp edge at the O.D. where it first contacts the die approach angle (Fig. 1). After a period of time, a fine, very small "ring" is formed at this point of contact (Fig. 2). As soon as this ring forms, the die should be re-

Lapping the die to size, using a diamond powder.



polished to remove it. If not, fine particles of carbide will gradually begin to break out resulting in a fairly rapid increase in die wear at this point until the surface at the ring becomes so rough as to cause pickup and even scoring of the bearing.

Lubrication and Die Wear

The length of time the average die will operate before this ring begins to form varies with the individual installation and also depends to a great extent on the effectiveness with which the case and the die are lubricated. From this standpoint it is highly important to see that the lubricant is carried through the die by the shell case. The most effective means of producing this result is to oxidize the shell case or provide it between draws with a thin rust coating to which the lubricant will adhere. As to the lubricants themselves, a great variety of different types are currently being used and no definite conclusions have been reached as to the most effective type for any given installation.

It is good practice in drawing shell cases with carbide dies to establish a definite period at the end of which the dies should be removed for polishing. No exact time interval can be given, however, some companies being able to run three to four days before polishing, while others re-polish their dies every 8 hrs. The best practice is to watch the operation fairly carefully at the outset and determine the approximate period of time required before the fine ring begins to form.

The ring formed in a carbide die when drawing shell cases is much narrower than that experienced in drawing wire or tubing. This is due to the fact that there is more of a line contact between the case and the die than in any other forms of steel drawing operations.

To remove the light rings, the major requirement as far as equipment is concerned is the provision of a lathe large enough to handle the dies, a flexible shaft or similar type of hand grinder. To remove the rings a brass rod is placed in the flexible shaft or hand grinder and with this the ring is removed and the surface smoothed out, using a No. 3 diamond powder. The surface is then polished with a felt wheel in the flexible shaft or hand grinder, using No. 5 diamond powder (Fig. 3).

In servicing carbide dies it is important that any pickup on the bearing surface of the dies be carefully removed. This is particularly true on the final draw die. If pickup is removed with a stone, emery cloth, etc., the die can easily be worn out faster in polishing it than in normal service. The tolerance on the bearing diameter of the final draw die is normally only 0.002 in. and once this diameter has been exceeded, the die (unless it can be re-cut to a larger draw) will have to be scrapped. One preliminary and intermediate drawing operations, this is not quite as critical, but nevertheless here also it is quite possible to wear the die out faster in servicing it than it does in actual use. Best practice is to cut any pickup off carefully with a sharp scraper and then polish the surface.

Die Sizes and Re-Cutting

As the result of cooperative study with the Ordnance Division and shell case producers, it has been possible to standardize carbide dies so that a single basic die size can be used for all drawing operations from the first to the final draw on any given type of shell case. As a matter of fact, it is possible to start with a die for the final draw of a 37 mm. shell case, gradually re-cut it as the die wears to the first draw on the 37 mm., and when worn out for this operation, re-cut it to handle successive draws on 40 mm. shell cases. Similarly, a single die size can be used for 3-in. anti-aircraft and 105 mm. shell cases.

At the present time standardization work is also going on to permit interchangeability of dies between the 75 and 57 mm. shell cases. On the 20 mm. and the 90 mm. shell cases — the two extremes of the range in which steel shell cases are now being produced — one set of dies can also be re-cut for all draws, but the die cannot be re-cut beyond this to handle other sizes of shell cases.

For re-cutting of dies, an internal grinder is required. With this, and using a 100 grit diamond wheel, the bearing is first re-sized to within 0.001 in. of desired dimension. The approach angle and radii are then re-worked, using the same wheel. The wheel is now removed and a steel lap inserted in its place and the die is lapped to size, using a diamond powder (Fig. 4).

Final polishing is with a buffing wheel using a fine diamond powder which should always be mixed with olive oil. The buffing wheel should be used on a grinder or flexible shaft with the die mounted in the internal grinder. In re-cutting, it is also important to re-establish the back relief angle to the correct specification.

Proper die maintenance, as to removing of the rings in the approach angle as soon as they begin to form, will do much to lengthen the life of a die on any particular operation and will greatly reduce the amount of re-cutting necessary. The more the ring is allowed to wear, the greater will be the pickup and the faster the die will wear as a whole. This is due to the formation of high spots in the approach angle, etc., which cut through the coating on the shell case and cause scoring and pickup.

In addition, proper attention to die maintenance will materially reduce the number of dies required for any given production set-up, an important point in connection with materials conservation, as well as in reducing the necessary die-inventory.

Chromium-Manganese "Stainless" Irons

PART 2

The first instalment of this article — of particular interest now because the "availability" of manganese is somewhat greater than that of nickel — appeared in our February issue. This concluding section gives engineering data on cold-working, mechanical properties and corrosion resistance. —The Editors

BY JOHN M. PARKS

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Effect of Cold Work

The influence of cold work was determined by examining the change in ultimate strength, per cent elongation, electrical resistivity and hardness. Figs. 6 to 10 show these variations with respect to the percentage of reduction in area by cold rolling.

The specimens for cold rolling were prepared from the hot rolled $\frac{1}{4}$-in. rod by repeated cold rolling and annealing. They were worked into a bar which was approximately twice as wide as it was thick. The bars were then given a 2-hr. anneal at 1800 deg. F. and furnace cooled in a hydrogen atmosphere. The bars were cold rolled in such a manner that the thinnest dimension was reduced. While most of the cold rolling produced a change in length, the width of the specimens did increase to such an extent that a 90 per cent reduction in area doubled the original width. Specimens were tested after annealing and after a 10, 20, 30, 45, 60, 75 and 90 per cent reduction in area.

The variation of ultimate strength with composition for different amounts of cold working is shown in Fig. 11. For a given per cent reduction in area, the ultimate strength drops as the manganese content increases, thus indicating that the work hardening characteristics of the lower manganese alloys are greater. The microstructures (Figs. 3 and 5) indicate that this change as a structure with less reject in it will work harden to a lesser extent with a given per cent reduction in area than a structure with more reject in it.

The relation between the ultimate strength and the percentage of manganese is one way of evaluating

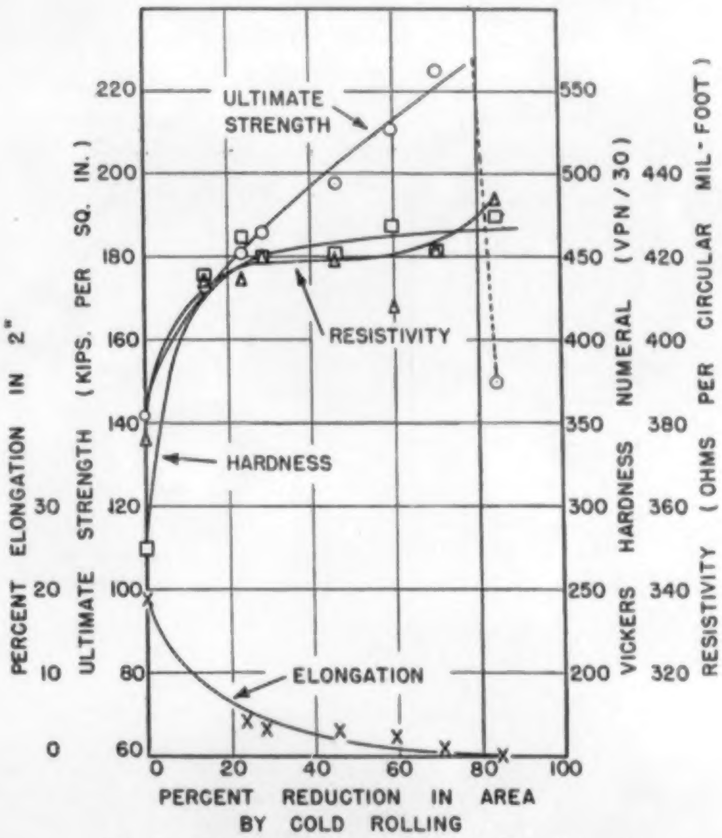


Fig. 6. Physical properties of alloy No. 4.

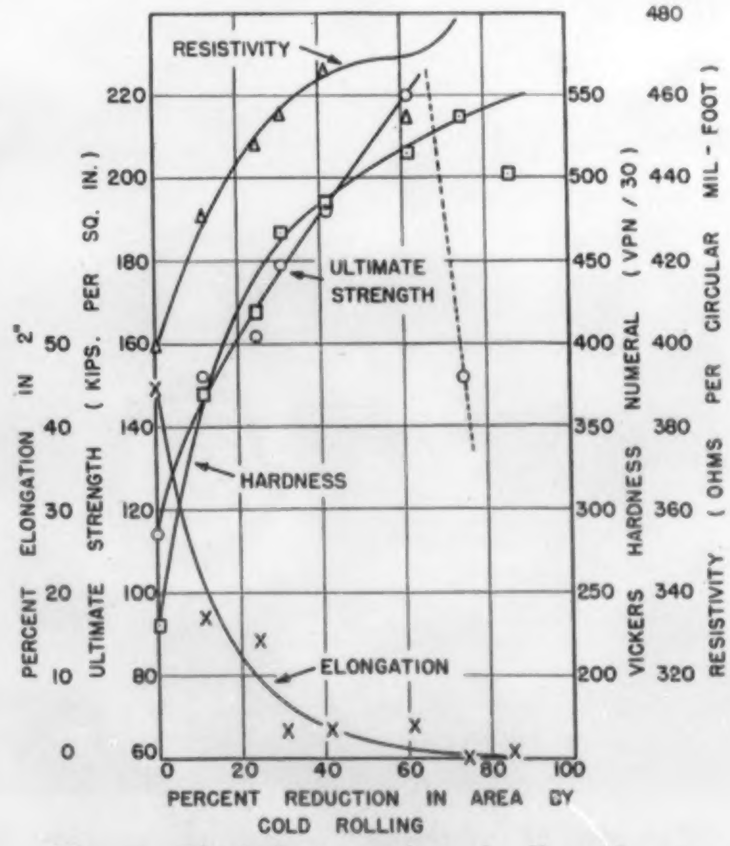
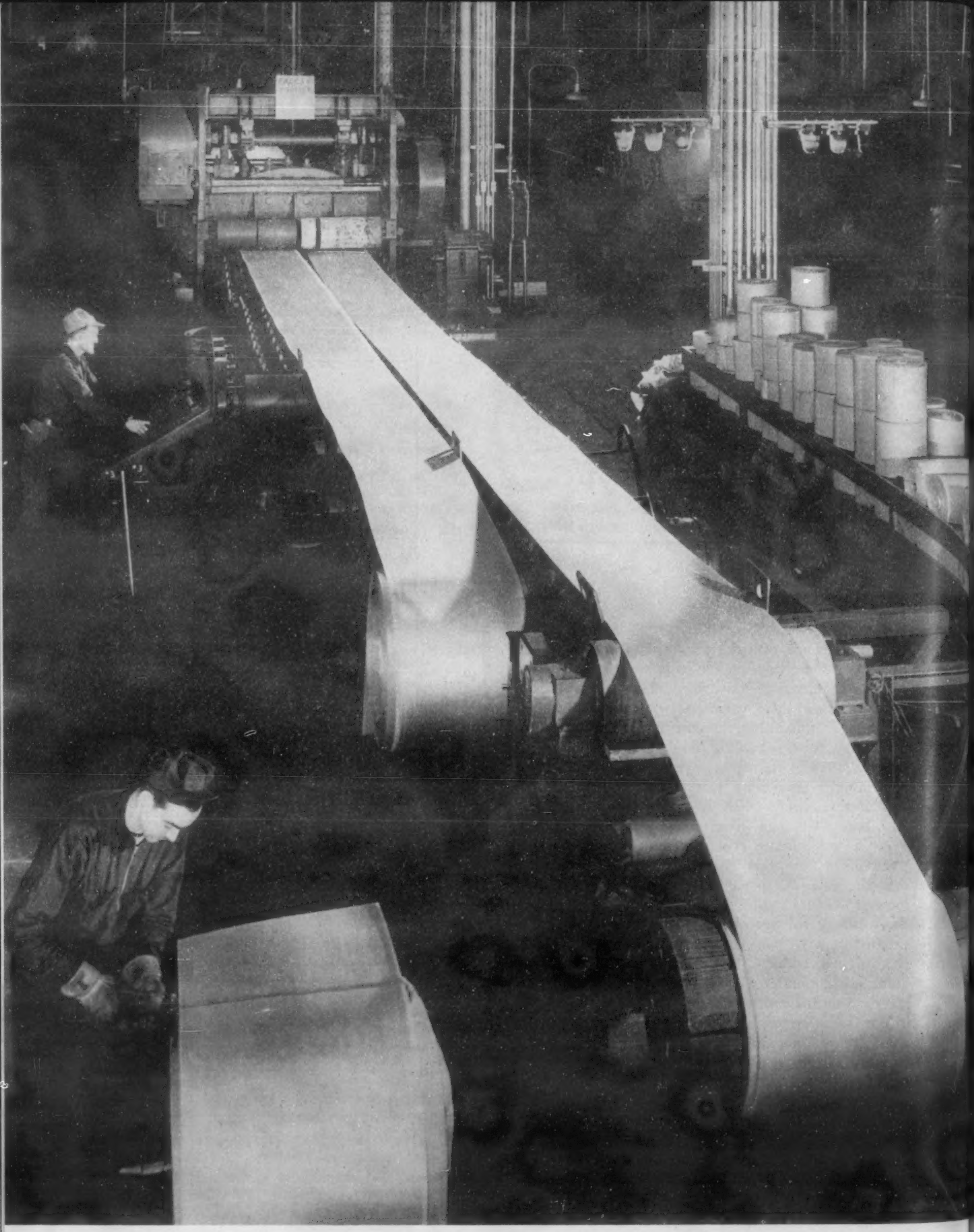


Fig. 7. Physical properties of alloy No. 5.



Wide coils of stainless steel coming off one of the five normalizing and pickling lines in the cold-rolling and stainless finishing plant at Massillon, Ohio. (Courtesy: Republic Steel Corp.)

the amount of reject appearing in the microstructure. As the per cent reduction in area becomes greater, the increase in strength of the 12 per cent Cr alloys with 20 per cent Mn compared with the 30 and 12 per cent Mn alloys is probably due to an optimum keying action as well as to the influence of manganese upon the ferrite-sigma phase relationships. The influence of manganese upon the 5 per cent Cr alloys is to increase the ultimate strength.

The per cent elongation values for the annealed alloys show an increase as the per cent manganese is increased. (See Fig. 12) This greater ductility is due to the decreasing amount of rejected ferrite found in the metal as the percentage of manganese is increased. The per cent elongation is only slightly influenced by the percentage of chromium as can be seen by Fig. 13. It will be observed in Figs. 12 and 13 that the alloy content has little if any influence upon the percentage of elongation after a reduction in area of over 40 per cent.

On cold working, the resistivity rises and then approaches a constant value as the percentage of reduction in area increases. When the metal is overworked, the resistivity rises rapidly thus indicating that rolling cracks have been produced. The resistivity increases as the chromium and manganese contents increase. Two factors operate to make this possible. The first factor has to do with the addition of chromium and manganese to austenite. Since any alloy addition which goes into solution will tend to increase the resistivity of a solid solution, the resistivity of the higher chromium and manganese alloys should be higher. The second factor includes the influence of manganese and chromium upon the stabilization of austenite and upon the decomposition of ferrite into austenite and sigma phase. In general the lesser the amount of reject, the greater the amount of alloy addition appearing in the solid solution and thus the greater the resistivity of the alloy.

The hardness decreases with increasing amounts of chromium and manganese. See Figs. 14 and 15. This indicates that in the alloy ranges investigated, the manganese and chromium tend to decrease the amount of rejected ferrite either by increasing the stability of the austenite or by promoting the decomposition of ferrite. As the cooling rate investigation indicated, the decomposition of ferrite has little influence upon the hardness of the alloys and thus the primary effect of the chromium and manganese must be the stabilization of the austenite. The hardness curves follow the same general pattern as did the ultimate strength curves. This trend is due to the fact that both the ultimate strength and hard-

Fig. 8. Physical properties of alloy No. 6.

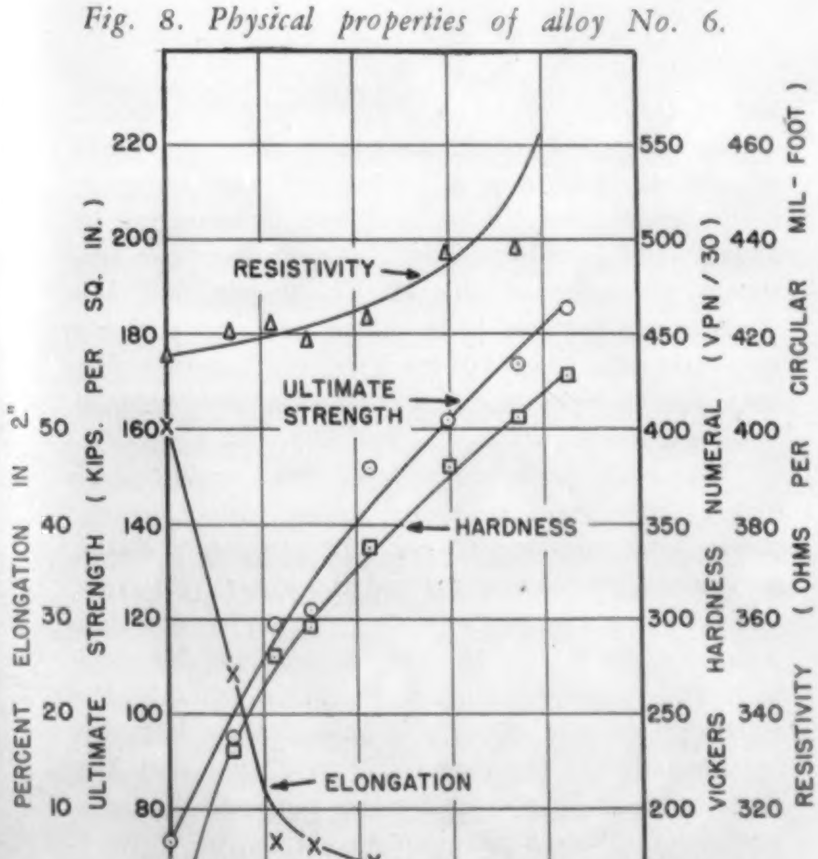
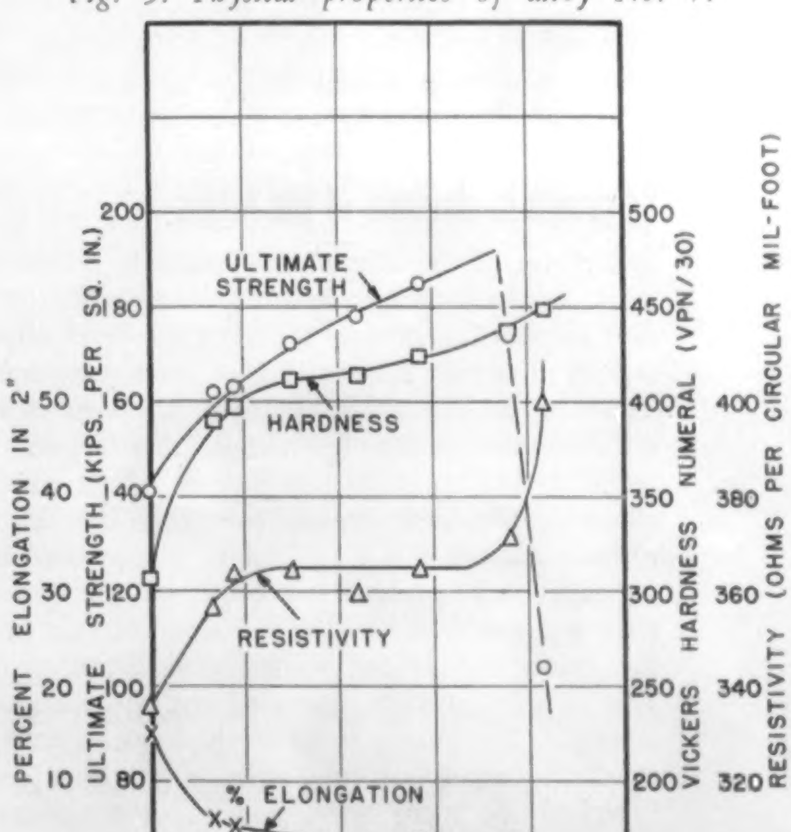


Fig. 9. Physical properties of alloy No. 7.



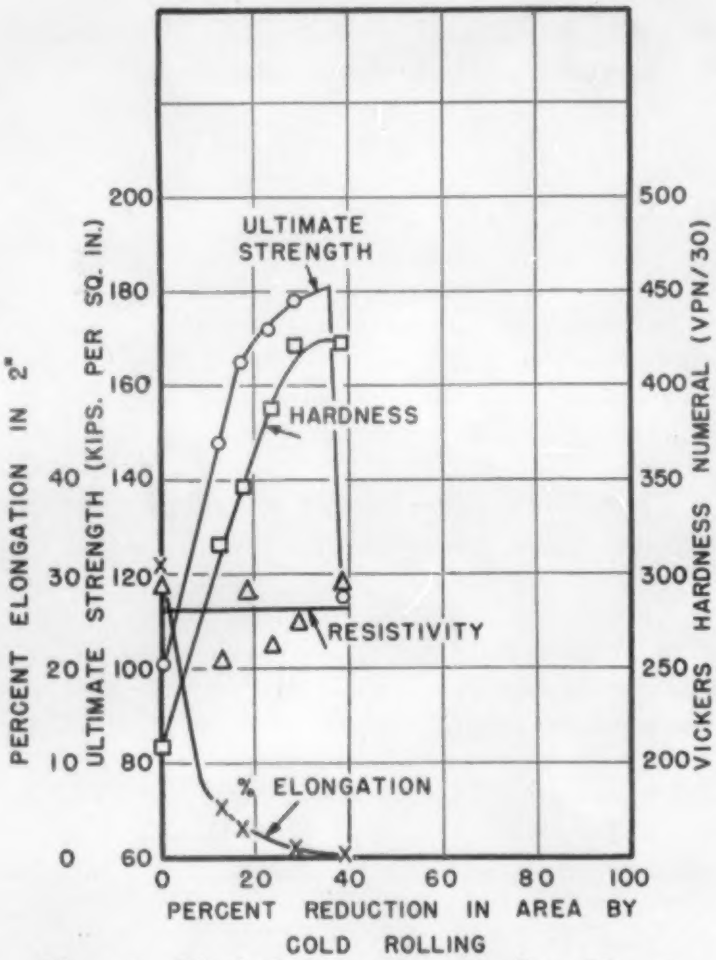


Fig. 10. Physical properties of alloy No. 8.

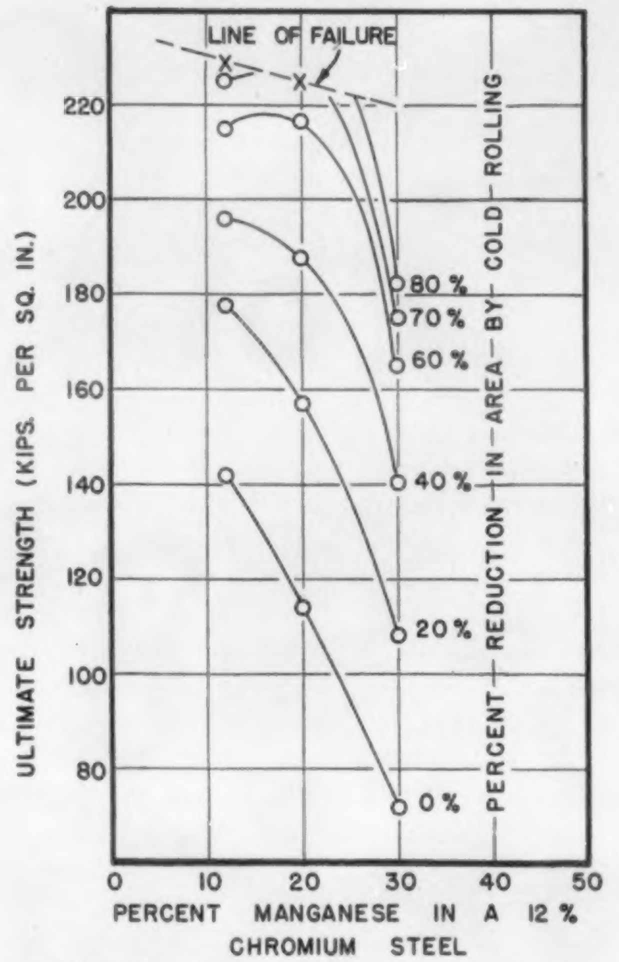


Fig. 11. The influence of cold rolling and manganese content upon ultimate strength for the 12 per cent Cr steels.

ness are directly related to the structural changes which are indicated by the constitutional diagrams.

Corrosion Resistance of the Alloys

Samples of the alloys were tested in several corrosive media. Strauss solution consisting of 8 per cent sulphuric acid and 1 per cent copper sulphate rapidly dissolves these alloys at room temperature. The low corrosion resistance to sulphuric acid is quite common in the high manganese alloys and it is believed that the high manganese content of these alloys is the basic reason for their lack of corrosion resistance. A solution using the same normality and hydrogen ion-copper ion concentration ratio was made using in one case a chloride ion as the anion and in the second case, a nitrate ion. The chloride solution corroded the specimens very rapidly. The nitrate solution had not appreciably attacked the specimens after a 48-hr. period. Weighed specimens were used in determining the amount of corrosion loss. The loss in weight of the specimens tested in the nitrate solution was less than the errors between the analytical balance weights. No intergranular corrosion was noted in any of these alloys when a microsection was taken.

The adaptability of the chromium-manganese steels with small additions of nickel, titanium, copper, molybdenum, and silicon have been investigated by Legat[13] and by Chimushin[20]. Legat gives the corrosion resistance of the 18 Cr, 9 per cent Mn steels to 0.5 per cent hydrochloric acid, 0.5 per cent sulphuric acid, and 10 per cent nitric acid. His tests also indicate the low corrosion resistance of these manganese steels.

These steels with and without small additions of nickel show good resistance to the dilute hydrochloric acid solution; 10 per cent nitric acid shows some attack on these steels and the loss ranges from 0.05 to 0.5 grams per sq. meter per hr. Chimushin considers the 9 Cr, 18 Mn, 3 per cent Ni steel with and without titanium additions, suitable for apparatus used in nitric acid manufacture but also considers the 18 per cent Cr, 7 to 17 per cent Mn steels to be of little value for this purpose. In these steels the ratio of titanium to carbon of 5 to 1 must be maintained.

The standard procedure for determining corrosion resistance is satisfactorily outlined in the description of the Huey test[22].

Figs. 12, 13, 14 and 15. The influence of cold rolling and composition upon the percentage of elongation and hardness.

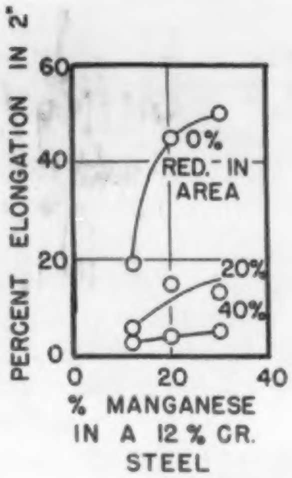


Fig. 12

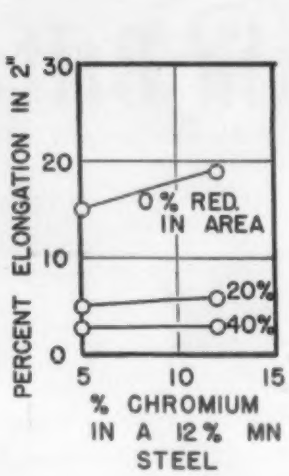


Fig. 13

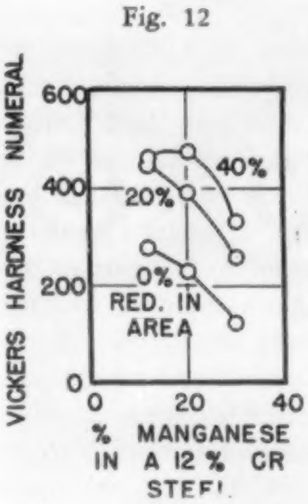


Fig. 14

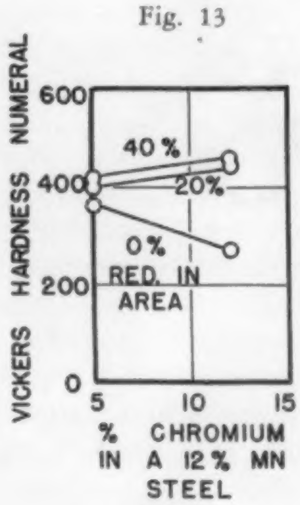


Fig. 15

Summary and Conclusions

The structure of the chromium-manganese irons containing from 5 to 12 per cent Cr and from 12 to 30 per cent Mn is duplex and consists of austenite and ferrite or austenite and sigma phase depending upon the composition and heat treatment of the steel. The influence of manganese is to reduce the amount of rejection while the chromium from 5 to 12 per cent has little influence upon the amount of rejection. The effect of water quenching and furnace cooling upon the hardness has little influence although the decomposition of ferrite into sigma phase is encouraged by the slower cooling.

The irons studied have low corrosion resistance to sulphuric acid and hydrochloric acid although they possess fair resistance to nitric acid. Although the literature is saturated with corrosion resistance data, further tests should be run either under actual service conditions or by use of the Huey Test in order to obtain comparable corrosion data.

Cold rolling tests indicate that greater hardening is obtained for a given percentage reduction when cold working the lower manganese irons. In general the 12 per cent Cr irons will be able to be worked to about a 60 per cent reduction in area before they start to fail due to overworking. In this working process, an ultimate strength of over 200,000 lbs. per sq. in. may be attained. The 5 per cent Cr irons do not attain this strength on cold working. The percentage of elongation drops rapidly as the amount of cold reduction increases and asymptotically approaches zero. Figs. 6 to 10 reveal the general effects of cold work upon these low chromium alloys.

The commercial use of these irons for structural purposes may be of some importance. At the present stage of development, the ultimate strengths of these cold worked irons are not equal to the ultimate strengths of the cold worked chromium-nickel steels although increasing the strength of the chromium-manganese irons by use of molybdenum, titanium, and other elements may overcome this difficulty. The chromium-manganese irons have equal if not better ultimate strength in the annealed condition compared with the chromium-nickel steels in the same condition. This may be of some importance in the consideration of these irons for welded structures or for casting purposes especially if die casting of steels ever becomes a reality.

Additional research could well be spent in trying to perfect the iron-chromium-manganese alloys. The influence of carbon is given in some detail by Brühl but the influence of small amounts of titanium, molybdenum, columbium, silicon, vanadium and copper upon the physical properties and the structure is not too well known. The addition of these elements to the chromium-manganese-iron base may make a very satisfactory alloy and thus enable it to compete more favorably with the chromium-nickel steels.

Further research with respect to carbon additions is under way at the present time and it is hoped that, by proper heat treatment and cold work followed by heat treatment, an ultimate strength equal to the chromium-nickel steels may be attained.

Acknowledgments

The author is deeply indebted to Dr. M. A. Hunter and the metallurgy department of Rensselaer Polytechnic Institute for their helpful advice and friendly assistance. Due appreciation is also extended to Dr. J. M. Lohr and the Driver-Harris Co. for their assistance and cooperation which consisted of melting duplicate heats and forging and hot rolling all of the alloys which were investigated.

Tin Conservation in Britain—II

One hears very often these days that American wartime production, design and management problems might be simplified in certain cases by more careful scrutiny of British experience with similar situations. Here, therefore, for the benefit of those American engineers who are harassed by the need to design products using no-tin or low-tin alloys and to solve manufacturing problems precipitated by the use of unfamiliar tinless alloys, is a review of British practice in formulating and handling solders, babbitt bearings, bronzes and protective coatings that hold the use of tin at a minimum.

The first half of this article, on the general tin problem and tin plate, appeared in our February issue.
—The Editors

by JOHN IRELAND

General Manager of the Tin Research Institute of Great Britain

SOLDER ACCOUNTS FOR almost 20 per cent of tin consumption. It is most commonly used as tin-lead alloys of various compositions. The function of tin is to provide a low melting point alloy which readily "wets" and adheres tightly to other metals, and, by varying its proportion, to provide solders with a range of melting points and varying speeds of solidification.

There is no difficulty in finding alloys with which quite strong soldered joints can be made. The use of some of these as substitutes in the present emergency is ruled out by reason of scarcity, as for instance, cadmium. A number of alloys have an inconveniently low melting point, such as those containing bismuth. Apart from costliness, these are useful only at or about room temperatures.

Substitute Solders

There are, however, numerous alloys containing 80 per cent or more of lead alloyed with up to 5 per cent of silver and a few per cent of antimony, and so on. All these make serviceable joints. They have some drawbacks however. For instance, lead-rich solders are in some cases less resistant to corrosion, and although the temperatures at which they have to be applied are some 100 deg. C. (200 deg. F.) above that of tin solder, they have a lower creep and fatigue strength at such temperatures as are commonly met with in processing food cans or in the armatures of high-duty electrical gear.

[This statement is not in accord with the findings of R. H. Lueck, "Wartime Changes in Metal Containers," *Food Industries,* Aug. 1942, pp. 57-63, who says that creep tests at sterilizing temperatures (250 deg. C., 480 deg. F.) shows better strength for 97.5 Pb, 2.5 Ag or 92.75 Pb, 2.25 Ag, 5 per cent Sn than for 60 Pb, 40 per cent Sn. Except for canned milk, the United States canmakers have switched almost completely to lead-silver. The long use of the Silberstein lead-silver-copper solder in electrical equipment indicates that, whatever the laboratory tests say, the solder is usable in actual service.—*Editorial Note.*]

There is the further difficulty that solders containing little or no tin have difficulty in wetting the surfaces of the metals to be joined, unless an active flux is used. This involves slower soldering operations and greater care is necessary to get rid of flux residues. With these difficulties in mind, substitution can be and is being effected.

The soldering of can bodies absorbs an important amount of tin, and in substituting a lead-rich solder in place of the 50/50 alloy commonly employed, the higher temperatures cause charring of some qualities of lacquers. This difficulty has not yet been overcome.

Other and so far more fruitful measures of conservation have included: First, the complete elimination of the use of solder; second, use of solders of lower tin content; and third, the use of restricted amounts of solder. The simplest example of the first measure was the prohibition of the use of solder for smoothing-off automobile body work. Other methods of joining, such as brazing and welding, have been adopted, but as new plant and new production schemes are involved, these have not often proved practicable.

Revised Specifications

The use of solders with a lower tin content has been studied by a special committee of the British Standards Institute, and a revised specification containing only five qualities of solder has been published, as shown in the Table. These provide an

economical solder for each type of use.

[Solders C, G, and M have tin contents above the maximum prescribed in the United States by WPB. There is room for some argument whether the low-tin solders may not tend to be applied more heavily so that the actual weight of tin, when lead-tin solders are used, may sometimes be as great as when lower lead contents are employed. However, some soldering operations, with a sufficiently active flux are being carried on with lead-tin solders of only 5 or 10 per cent Sn.—*Editorial Note.*]

Still further progress on these lines is being studied and may be aided by the addition of other metals, particularly silver, but the supply position of such additional metals has to be carefully kept in view.

The prospect of saving by reducing the amount of solder used per joint is encouraging. Many millions of small electrical connections are made every week in telephone equipment, radio sets and other electrical instruments. So far only tin-rich solders have been found to give the necessary quick-setting reliable joint with a non-corrosive flux, but an important reduction in the amount of solder used can be effected by employing the solder in the form of thin wire, preferably cored with solder. In one case a firm changed over from 14 gage solder wire to 16 gage, and used practically the same length of wire but consumed only 60 per cent of the weight.

The joining of lead-sheathed cable also uses large amounts of tin, but it has been found that by carefully controlling the shape of the joint, that is, insuring that the solder gets between the lead surfaces to be joined, while the external wipe is kept to a minimum, the amount of solder used can be reduced to 30 per cent or less.

A typical joint is shown in Fig. 1. Such joints have passed all the usual tests, and action is being taken to improve current practice. Similar economy is possible in the joining of lead piping in domestic water and gas installations. The male and female cone joint shown in Fig. 2 has withstood 1,130 lbs. per sq. in., at which pressure the lead pipe itself fails.

Fig. 1. Joints on lead cable made by the pot and ladle method. The ordinary wiped joint (right) required 21 oz. of solder, but the new type of joint (left) needed only 7 oz. (Courtesy: Post Office Engineering Research Station)

Table of Analyses of British Standard Soft Solders (Extract from B.S. 219: 1942)

B.S. Grade	Use for which the solder is primarily intended	Tin, per cent[2] Max.	Tin, per cent[2] Min.	Antimony, per cent Min.	Antimony, per cent Max.	Lead	Impurities: Aluminum, Zinc or Cadmium (See Note[1])	Impurities: Iron, per cent Max.	Impurities: Arsenic, per cent Max.	Impurities: Total, per cent Max.
C	Tinsmiths', coppersmiths' fine work, general work	40.0	39.0	2.0	2.4	The Remainder	0	0.02	0.05	0.25
D	Lead cable wiped joints, plumbers' wiped joints	30.0	29.0	1.0	1.7	The Remainder	0	0.02	0.05	0.25
G	General electrical purposes, tinned electrical joints. Zinc and galvanized iron-work	42.0	41.0	—	0.4	The Remainder	0	0.02	0.05	0.25
M	Special tinsmiths' fine work and hand soldering	45.0	44.0	2.3	2.7	The Remainder	0	0.02	0.05	0.25
N	Dipping solder, for radiator manufacture, etc.	18.5	18.0	0.75	1.0	The Remainder	0	0.02	0.03	0.25

[1] The figure 0 implies that the amount of the element present must be so small as not to be determinable in ordinary routine chemical analysis.

[2] When solders with lower percentages of tin are now in satisfactory use for any of the above purposes they can continue to be so employed.

This joint is made by cutting the ends of the lead pipe with the tools shown in Fig. 3. Solder in the form of prefluxed foil is wrapped around the male end and the joint is assembled. It is then heated with a blow lamp until the foil melts, thus sweating the two ends together. The making of this type of joint calls for no more than the usual amount of skill, takes only a few minutes to complete, and requires only 1 per cent of the solder used on the normal plumber's wiped joint.

[Lead-burning techniques, as stated by Willard (*Metals and Alloys*, Feb. 1941, page 174) can be used to avoid need for any wiping solder. A wiping scheme by which a much smaller solder fillet than the ordinary one does as good a job, is reported by J. T. Lowe, "Using less tin in cable joining, *Bell Laboratories Record*, July 1942, pages 276-277.—*Editorial Note.*]

Replacements for Tin in Bronzes

Bronze and gunmetal normally amount to about 20 per cent of Britain's tin consumption. In these alloys tin is used to the extent of from 1 to 15 per cent, alloyed chiefly with copper and small quantities of phosphorus, lead, and so on. The function of tin is to provide strength and corrosion resistance. Where however, these qualities can be pared down, economy has in the first place been effected by restricting the use of richer tin alloys and replacing them with some alloy containing less tin, *e.g.* the 88-10-2 has been replaced with the 88-8-4 alloy so widely adopted in the United States, or with 85-5-5-5.

This type of change has been possible in many cases, and substantial economies have been effected. In a few instances zinc has replaced tin entirely where brass can be substituted for bronze. In other cases it has been possible to utilize steel, as for instance, for the backing material of bearings lined with white metal.

From the metallurgical engineer's viewpoint the most interesting substitution is the use of silicon bronzes. These have been made the subject of British Standards War Emergency Specification No. 1030. The composition is: Si 1.5 to 5, Mn 1.5 max., Zn 5 max., and Fe 2.5 per cent max. Test bars must have an ultimate tensile strength of 45,000 lbs. per sq. in. and an elongation of 15 per cent.

Alloys of this type have been on the market for a number of years, and it is established that the silicon confers excellent resistance to corrosion with good tensile strength. While tin was freely available the tin bronzes were much more extensively used, but under present conditions silicon bronzes are arousing a wider interest. It is well worth while to study the special limitations, and to take the special precautions required in the casting of silicon bronze, and thus effect a greater degree of substitution than hitherto.

Bearings are another important use of tin. In this case it is used in three types of alloys, Babbitts, lead-rich white metals and bronze. Babbitt consists of about 90 per cent Sn, alloyed with antimony and a little copper. The function of the tin is to provide a surface that retains its oil film, resists wear even under considerable load and at high speeds, does not score or seize on to the shaft, and stands up even when the oil is scarce and grit gets between the rubbing surfaces.

Alternates in Bearings

No metal provides so satisfactory a combination of these qualities as does tin [This might be modified to except cadmium, were the cadmium supply sufficient to afford relief.—*Editorial Note.*], but in many bearings, conditions of loading, cooling or lubrication can be so controlled that substitution can be effected.

In general, lead is the substitute metal employed; this is usually hardened with antimony, tin, and copper. The chief limitation of lead-base bearing metals is their tendency to squeeze out, and for this reason tin-rich Babbitts are still standard practice in England for high-speed bearings subject to fluctuating loads, such as big-end and crankshaft bearings of internal combustion engines.

For other bearings working under less severe conditions, or where the bearing lining can be kept very thin, the lead-base alloys are now being adopted. This is particularly true of bearings in a wide variety of machinery which operates under only moderately severe conditions. Formerly the ease of manufacture and the wide margin of safety provided by a tin-rich alloy has made bearings containing 40 to 60 per cent of tin extremely popular.

[These alloys, essentially of solder composition, have not been considered as affording a useful "margin of safety" in the United States because of their very low melting point and extreme softness. Their use here seems long to have been abandoned as a woeful waste of tin, the bearing behavior being definitely inferior to regular tin-base or regular lead-base Babbitts.—*Editorial Note.*]

The present British program excludes such uses of tin and substitutes lead-rich alloys. This will effect a large economy, as tin-rich bearings are scrapped and replaced with alloys containing only 1/4 or 1/5 as much tin, some sections of the industry should be self-supporting for a considerable period.

Valuable American Developments

Much research has been expended on improving lead-base alloys. Additions of calcium, arsenic, cadmium and a host of other elements, alone or in combination, have been used. Each has its limitations,

and special precautions have to be taken either in manufacture, in operation, or in both. The bonding of the lead-rich white metal to its backing is always difficult, and in operation troubles may arise through the rapid loss of strength at high temperatures.

Recent experiments in the United States in which small additions of silver or of arsenic have been utilized, may make practicable a wider substitution of lead-base bearings, and this and other possibilities are being studied carefully.

In many lesser uses of tin, substitution has been carried to the 100 per cent point. For instance, no pewter is now allowed to be made. Tin foil for wrapping is almost eliminated. It was extensively used for wrapping the more expensive grades of cheese. "Substitution" has been facilitated by the complete disappearance of such cheese from the English market.

Collapsible tubes have been less easy to eliminate, and indeed for certain medical preparations no sound substitute has been developed, but such uses are small. No non-metallic containers so far proposed have received broad acceptance. From the tonnage viewpoint the most important use was as a container for tooth paste. In this case the problem was complicated by wartime changes in the composition of the pastes, but a change-over to lead, coated with a thin veneer of tin, has not been effected, and for at least 90 per cent of the tin previously used in collapsible tubes, lead is the effective substitute.

[American experiments with plastic tubes and in feasible shifts to other methods of packaging than tubes, indicate that metal collapsible tubes that require even a thin tin coating will soon be dispensed with.—*Editorial Note.*]

Other Economies

Tin oxide as an opacifier in vitreous enamels and earthenware glazes has been practically eliminated. Where shipping facilities permit importation, substitute metallic oxides will be employed, but in general, a lower standard of whiteness will have to be accepted.

Apart from metallurgical or chemical questions, many other difficulties are involved in tin economy, such as availability of plant, lack of workpeople experienced in the new techniques, and so on.

Substitution is a balance between the scarcity of the element concerned and the effort needed to dispense with it. Every aspect of each use of tin is being carefully studied in co-relation with the changing conditions imposed by Britain's intensifying war effort. Substitution will be carried further as alternative techniques are brought into production, but the chief economy is being effected by everyone learning to go without until the war is brought to a successful conclusion.

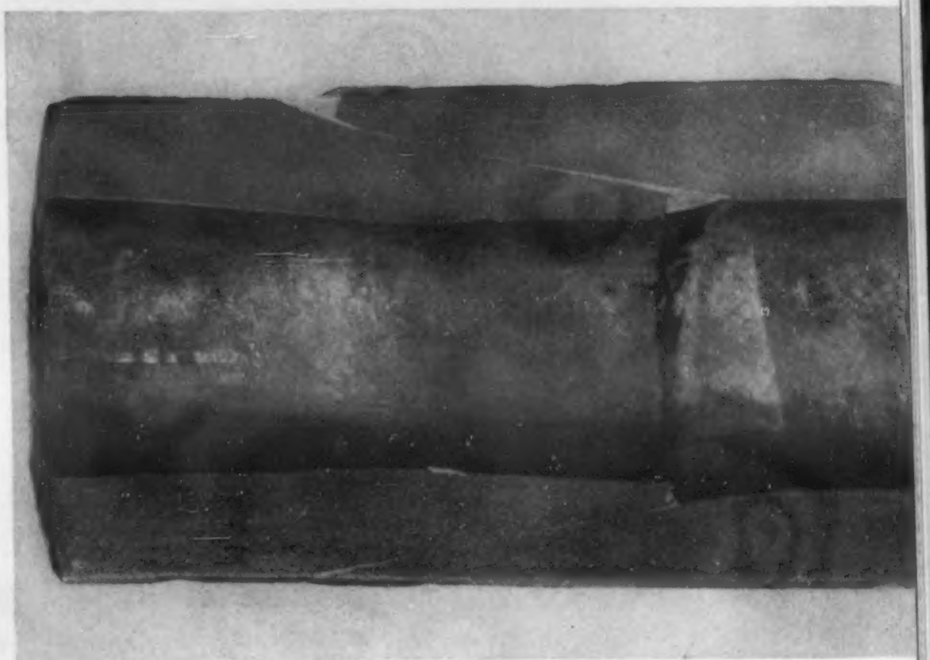


Fig. 2. Section through a standard $\frac{1}{2}$-in. bore lead pipe joined with "Amalgaline" solder foil. This joint withstood a pressure of 1,130 lbs. per sq. in.

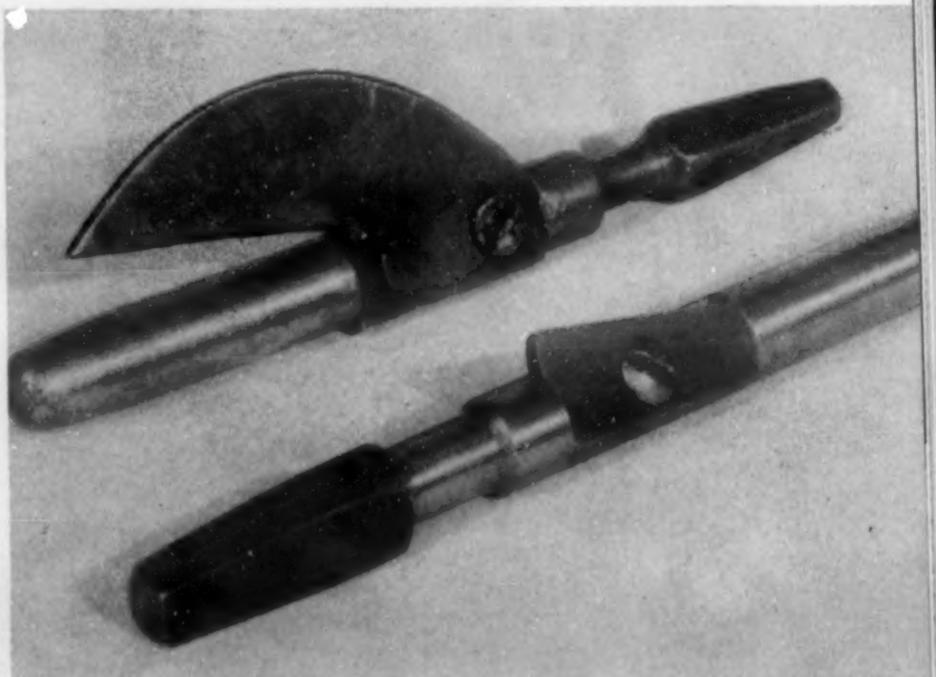


Fig. 3. These simple tools are used to make male and female cones on lead pipe prior to joining with thin solder foil. (Courtesy: George Jennings [Lambeth] Ltd.)

Precision Gages of Glass

by COL. H. B. HAMBLETON

Chief, Gage Section, Office Chief of Ordnance

Brig. Gen. H. T. Safford examines an exhibit of standard types of new glass gages replacing steel gages at the Frankford Arsenal.

A plain plug glass gage, which replaces a steel gage in the Frankford Arsenal, is used to determine the inside diameter of a metal part.

Here is another striking example of conservation in the use of materials for and by Army Ordnance. This particular development—the use of glass instead of steel for precision gages—has a double-barreled interest for our readers: Not only does it involve the replacement of a metal by a non-metal in a "traditional" metal-application, but it provides a new approach to gaging and inspection practice for metal-working engineers. No doubt this particular "substitution" can be extended to analogous critical steel uses, and—as the author states—it does appear to be permanent in nature, with everything that means for post-war applications. —The Editors.

THE PROGRAM FOR CONSERVATION of critical materials set up months ago by the Ordnance Department of the U. S. Army, has gone a long way since its inception. Furthermore, its research engineers have made some changes, quite revolutionary in character and far reaching in their results.

Among the most spectacular is the substitution of glass for steel in gages,—this change releases critical tool steel, which is vitally needed for other uses in munitions manufacture. The amount is not inconsiderable as there are hundreds of thousands of steel gages now in use in ordnance arsenals, ordnance owned factories and industry in general, employed in turning out munitions.

Glass vs. Steel

Glass gages, with their frangibility characteristic, would seem to be an anomaly, especially in view of the fact that until now, gages have been made from the toughest of steels. This anomaly dissolves when one reviews some of the other characteristics inherent in glass.

In the first place, frangibility is not the liability one might at first expect; in fact, it is an asset, for it teaches the inspectors to have respect for a very nice tool. Furthermore, a dropped glass gage either breaks beyond repair and thus automatically retires itself, or it is undamaged and its usefulness unimpaired. On the other hand, a dropped steel gage is always under suspicion until checked in the laboratory, for it may be bent or sprung just enough to go undetected by the inspector and thus pass poor work.

Increased dimensional stability is also obtained through another physical property of glass—its lower thermal conductivity as compared with steel. Due to the exceptionally small tolerances required on much of our munitions production, even the heat from the

Markings on the handles of new glass gages, which replace steel gages in the Frankford Arsenal, are produced by acid etching.

A steel plug gage is compared with a glass plug gage which replaces it at the Frankford Arsenal.

inspector's fingers will occasionally expand a steel gage to a point where considerable trouble is thereby caused. The thermal conductivity of glass is so low that no difficulty is experienced from this factor.

Another physical property inherent with glass is a coefficient of expansion that is low; this can however, be made to vary by changing the composition of the glass. Through this control, glass for gages can be made up with almost any desirable coefficient of expansion, which is a material advantage, in that, the parts gaged vary widely as to this factor. On the other hand, no such flexibility is possible with the steel used in gages, as its coefficient of expansion is definitely set at 0.000006 in. per in. per 1 deg. F.

Directly related to this characteristic is the fact that the lower the coefficient of expansion of glass, the greater is its hardness and stability against chemical attack and weathering in a humid atmosphere. Naturally, hardness and a high wear resistance is a "must" for gages regardless of the material from which they are made. Experience has already proved that glass gages are the equal if not the superior of steel gages from the standpoint of wear.

A Direct Comparison on Cartridge Cases

More than six months use at the Frankford Arsenal and elsewhere have proven the practicality of glass gages beyond peradventure, although they are still more or less in the experimental stage. This use indicates that eventually, a large proportion of the standard plain gages in use will be made from glass. Furthermore, the advantages of glass over steel for this purpose are so many, that there is little doubt but what the glass gage has come to stay and that it will be standard with industry after the war.

Checking an inside diameter of a cartridge case with one of the glass gages, which are replacing steel gages.

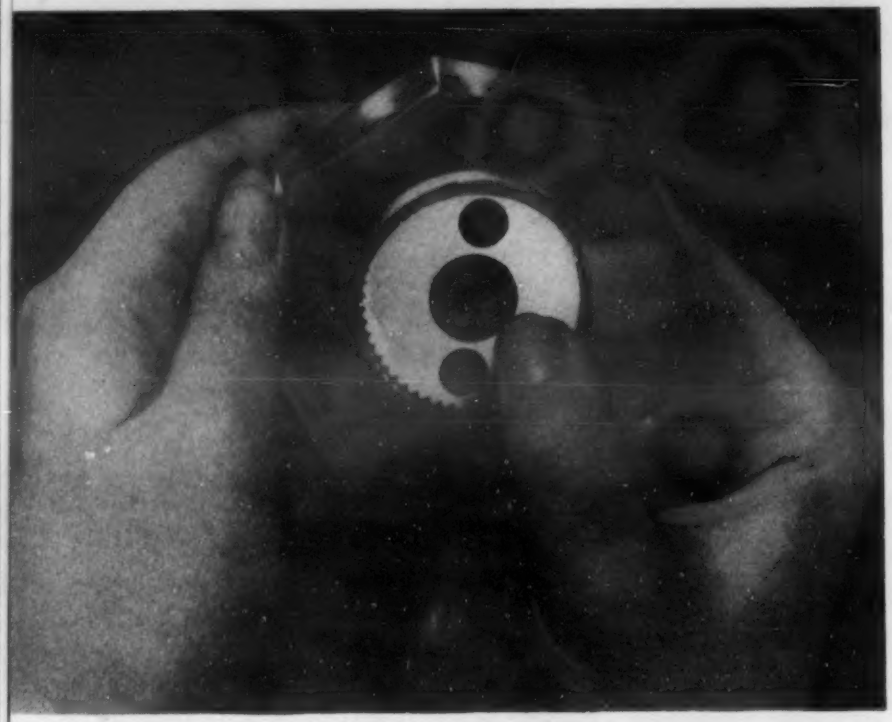
A direct comparison was recently made between a glass and a steel gage used on identical work, a medium size artillery cartridge case. The glass gage had checked approximately 163,000 cases without perceptible wear, not even as much as 0.00005 in. wear, which was quite remarkable. The steel gage had checked about 800,000 cases and showed a wear of 0.0007 in. Particular attention is directed to the fact that the glass gage was originally almost up to maximum of tolerance permitted and the steel gage was to the maximum tolerance.

This makes the comparison all the more striking. This particular function is a real test for any gage inasmuch as the component is drawn, not machined, and the gage has to round up the mouth of the cartridge case. A drawn cartridge case is not perfectly round at the mouth. Furthermore, it is to be noted that brass is much harder on a gage than steel, inasmuch as brass has a tendency to lap the gage.

Types of Gages and of Glass

Already the Ordnance Department has standardized on the following four types of glass gages: (1) Plug gages of $1/4$ in. and more in diameter which include plain plugs, no-go and double end plain plugs; (2) ring gages, go and no-go, plain, twin and combination ring and snap gages; (3) snap gages and (4) profile and position gages. There is little doubt but that there will also be included certain types of flush pin gages with pins in excess of $3/8$ in. and chamber gages for measuring the profile of a part such, for instance, as a cartridge case.

If this idea proves out as anticipated, chamber gage practice will be revolutionized. While thread gages of glass are considered impractical at this time, it might be possible to mold coarse threaded sections of this material.



Checking the inside diameter of a cartridge case with one of the glass gages.

As to type of glass, the Ordnance Department will accept gages or gage blanks made from either lime glass or boro-silicate (Pyrex) glass or a light flint glass. However, it does not hold rigidly to the above types, but will accept gages of glass of different composition if full and sufficient evidence is provided that such proposed gages are equal in all respects to the gages covered by its specifications. Maximum hardness, maximum abrasive resistance and dimensional stability are requisite. In this connection we might state that the boro-silicate formulas are among the hardest and most abrasive resistant and the thermal expansion is only about a third or a quarter of the thermal expansion of most metals, and this includes the carbon steels.

In gaging, it is almost impossible to avoid scratching entirely, especially in certain types of work. Scratches on steel gages raise burrs which increase their size and permits them to pass offsize parts. While glass will also scratch, no burrs are raised thereby, and their usefulness remains unimpaired. Rust is another detriment to steel gages, and careful attention must be paid to their greasing every time they are put into temporary storage or shipped, and cleaning when put back into use again. On the other hand, there is no rusting with glass gages nor does perspiration etch them.

Greater visibility when gaging is possible with glass gages and they are light and more easily handled than are steel gages. Also seizing or galling, which is particularly noticeable when gaging copper or brass components with a steel plug gage is lacking when using glass gages. These factors have speeded up the work of gaging on some parts by as much as 50 per cent.

Glass manufacturers are showing a most cooperative interest in this program from the viewpoint of developing correct glass formulas and furnishing blanks made therefrom, to the gage manufacturers.

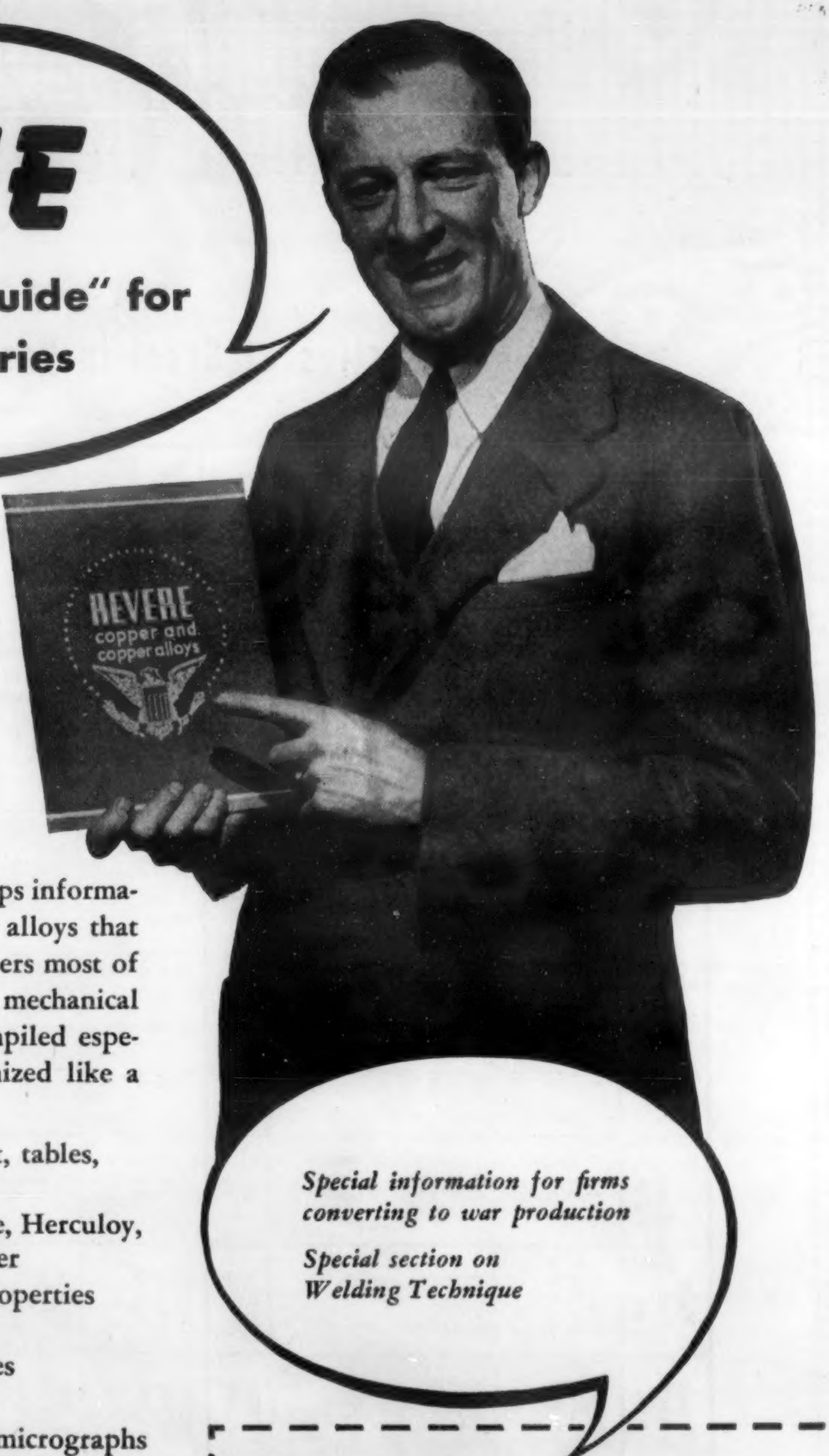
Manufacturers of Glass Gages

Glass manufacturers who have already furnished the Ordnance Department with gages include, the Corning Glass Works, Corning, N. Y.; the A. S. Heisey Co., Newark, Ohio; the Fischer & Porter Co., Hatboro, Pa.; the T. C. Wheaton Co., Millville, N. J., and the Specialty Glass Corp., Newfield, N. J. Among glass makers possibly equipped to manufacture glass gage blanks are the following: The Libbey Glass Co., Toledo, Ohio; the Sneath Glass Co., Hartford City, Ind.; the Duncan & Miller Glass Co., Washington, Pa.; the Federal Glass Co., Columbus, Ohio; the Anchor Hocking Glass Corp., Lancaster, Ohio, and the Jeannette Shade & Novelty Co., Jeannette, Pa.

In order to achieve the greatest mechanical strength possible, glass gage design is varied slightly from that used in the making up of steel gages. While the strength of glass in compression is usually in excess of 100,000 lbs. per sq. in., its tensile is down to between 5000 and 15,000 lbs. per sq. in. Therefore, increased area in many cross sections is incorporated in their design. Also, all exposed edges must be beveled or finished to a radius to minimize chipping or breakage when dropped or handled roughly.

One glass concern has designed a complete line of plug and ring blanks to correspond with the American gage design steel blanks as outlined in Commercial Standard, CS 8-41. Both molding technique and the functional use of glass gages were carefully considered while developing these designs. This is one of the most constructive moves in the glass gage field yet made within the glass industry. However, the ultimate is far from being attained at this date and glass companies will have to do considerable development work to produce satisfactory blanks.

The burden of educating the steel gage manufacturers in the proper methods of finish grinding the blanks will also fall on the shoulders of the glass industry. The service will include furnishing glass blanks with precision centers for final grinding at steel gage factories. This can be readily done as many glass companies have already developed considerable technique in such glass machines and could readily apply it to centering the gage blanks. It is quite possible that the glass companies making gage blanks would be called upon to do some rough grinding because of the diameter variation inherent in molding. They should also be in a position to advise steel gage makers as to the grinding wheel composition, grinding speed, coolant and method of final lapping as applied to the particular type of glass blank they are supplying.



REVERE
copper and copper alloys

Properties of Steel in Various Forms

	Form	Condition	Tensile Strength, p.s.i.	Yield Point, p.s.i.	Elong., 2 in.	Red'n. Area, %	Impact Strength, Ft.-lbs.	Brinell Hardness	Machinability, % B1112=100	Remarks
0.20% Carbon Steel	Steel Casting[1]	As cast	65,000	35,000	33	53	25 (i)	130	52	———
		Annealed	67,000	38,000	31	52	39 (i)	130	—	———
		Heat treated	69,000	42,000	33	57	40 (c)	138	—	Water-quenched from 1625°F., tempered at 1250°
	Bar Stock[2]	Hot rolled	67,000	45,000	32	60	50 (i)	135	52	———
		Cold drawn	75,000	64,000	20	52	48 (i)	156	60	———
		Core after carburizing & quenching	80,000	50,000	30	60	70 (i)	160	55	Cool and reheat to 1425°F., water quench.
		"	85,000	55,000	33	65	100 (i)	170	—	Cool and heat to 1625°F., oil quench; reheat to 1425 & water quench
	Forging	Untreated	67,000	45,000	32	60	50 (i)	135	52	
		Heat treated	80,000	50,000	30	60	70 (i)	160	55	Quenched
0.35% Carbon Steel	Steel Casting[3]	As cast	88,000	43,000	15	16	3 (c)	187	—	———
		Normalized	96,000	55,000	25	40	23 (c)	196	—	———
		Heat treated	105,000	70,000	18	44	31 (c)	207	55	Water-quenched from 1500°F., tempered at 1050°
	Bar Stock[4]	Hot rolled	88,000	55,000	30	56	20 (i)	175	60	———
		Cold drawn	92,000	60,000	25	50	—	200	65	———
		Heat treated	146,000	122,000	10	39	17 (i)	331	—	Water-quenched and temp. at 400°F.
		"	112,000	79,000	12	42	18 (i)	255	—	Oil-quenched and temp. at 400°F.
		"	104,000	72,000	17	47	29 (i)	223	50	Oil-quenched and temp. at 700°F.
	Forging	Untreated	88,000	55,000	30	56	—	—	—	———
		Heat treated	112,000	79,000	12	42	18 (i)	—	—	Oil-quenched and tempered at 400°F.

Average Analysis of Above Steels

	[1]Cast Steel	[2]SAE 1020—AISI C 1020 Bar	[3]Cast Steel	[4]SAE 1035—AISI C 1035 Bar
Carbon	0.19%	0.18-.23%	.36%	0.32- .38%
Manganese	0.74	0.30-.50	.75%	0.60-0.90
Silicon	0.37	———	.39%	———
Phosphorus	0.013	0.040 (max.)	.021%	0.040 (max.)
Sulphur	0.026	0.050 (max.)	.032%	0.050 (max.)

Note: These data apply to steel of about 1 inch section.

Compiled by Robert S. Burpo, Jr.

NUMBER 5

PROCESSES AND PROCEDURES
Welding

Welding Processes — a Summary

Welding is the process in which two or more pieces of metal are permanently joined by heating to a state of plasticity or of fusion — oftentimes accompanied by the application of pressure. Brazing or soldering being a method of joining metals by the use of lower metling point non-ferrous material (hence there is no fusion of the materials being joined), will not be considered in this brief outline of welding processes.

Gas Welding Processes

For convenience, welding will be discussed under two general headings: gas and electric processes. The gas welding processes are "fusion" processes; that is, they depend on the melting, or fusion, of the surfaces to be joined. Also a welding, or filler, rod is used. This rod may be similar in composition to the materials being welded.

In the gas welding processes the heat of the gas flame melts the rod and this fused material flows into the joint or space between the pieces being welded. This deposition of material from the welding rod plus superficial melting of the base metal being welded creates a strong bond. The weld has a structure similar to that of cast material because of its slow cooling from the molten state. Heat treatment after welding may aid in refining this cast structure as well as relieving stresses. Many commercial metals and alloys can be gas welded; however, high carbon, tool and stainless steels, malleable iron and a few non-ferrous metals are not usually welded by this process.

Of the common gases used for welding, a mixture of oxygen and acetylene (the oxyacetylene process) is most common. A torch that mixes and burns these two gases in controllable ratios is the important item in this welding process. By controlling the ratio of oxygen to acetylene being burned by his torch, the welder can produce a reducing (carburizing), neutral or oxidizing flame depending on requirements of the materials being welded. Welding rods are used in this process; this means that the welder has both hands occupied — one manipulating the torch, the other holding the welding rod. Some types of work, therefore, must be clamped in jigs before the operator can start welding.

Before welding, the surfaces to be joined must be cleaned so that they are free from scale, dirt, corrosion and grease. To help protect the molten weld material and to improve the soundness of the resulting weld, flux is used. This flux may be applied directly to the weld, or to the welding rod as a solid (powder or paste) or as a liquid.

The oxyacetylene torch is used largely for welding ferrous materials, especially sheet stock. Besides its wide application to welding, the oxyacetylene flame has other important uses such as brazing, flame cutting and flame hardening. Oxyacetylene welding apparatus may be very portable if bottled (or compressed) gases are used. For the large, fixed installations acetylene generators are often used; oxygen is usually purchased.

Portable and manually operated gas welding equipment has a low first cost and a very wide range of applications especially in the job shop, and in structural or maintenance fields. The larger installations in both job shops and high production factories likewise have wide adaptability. The automatic oxyacetylene equipment is used mostly with sheet steel (26 to 14 gage) in such operations as forming tubing.

Electric Welding Processes: Arc Welding

Welding by electricity is accomplished by two general methods: (1) arc welding (a fusion process) and (2) resistance welding (where the parts to be joined are heated to a plastic state by the passage of the electric current and then subjected to localized pressure which creates the weld).

In the various arc welding processes, an electric arc is formed between an electrode and the work to be welded. If needed, a "filler" material (obtained by melting a welding rod in the arc) can be fused with the molten base material to make the weld.

The DC carbon arc is one of the oldest electric welding processes. Here the work is usually positive and the graphite electrode is negative; a filler or welding rod is often used with this process. Equipment for manual single operator DC carbon arc welding is usually portable as either a gasoline, diesel or electric motor may be used to drive the DC generator. Multi-operator welding units are not generally portable.

In the DC metal arc welding process the arc is struck between the work and an electrode just as in the case of the DC carbon arc. In this process, however, the electrode is metallic and does double duty as electrode and as filler rod. In most commercial practice a shielded electrode is used. This is a metallic rod coated with a solid covering that forms a protective atmosphere about the weld and also has beneficial slagging properties under the influence of heat from the arc. This type of arc welding has a wide range of applications: ferrous materials, aluminum, copper alloys, nickel, Monel, Inconel, etc.

AC metal arcs are used in welding structural steels especially where heavy currents are used, or in welding in vertical or overhead positions, or if the operation is performed in restricted areas such as in curved sections or close to angles.

AC vs DC Arc Welding

Physically there is no difference between a weld produced with AC or DC current. Some of the advantages of each are listed below:

Advantages of AC Arc

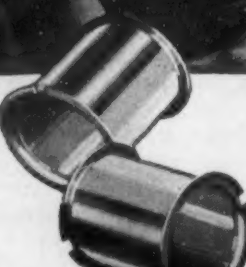
Easier to weld in vertical or overhead positions.
No moving parts if a transformer is used instead of a motor-generator set.
AC motor-generator efficiency is 65%; welding transformers are 86-89% efficient.
Most AC rods can be used for DC arc welding.
No-load losses are low.
Electrical characteristics of generator more favorable to welding.

Advantages of DC Arc

Easier to stabilize arc at lower current values.
Efficiency of DC welding equipment 50-60%.
Either bare or coated metallic electrodes can be used.
These electrodes cannot be used in AC welding: carbon, aluminum, copper-alloy, nickel, Inconel, Monel and bare steel. (They are OK for DC.)
The equipment for these various types of arc welding processes described above is available in a variety of forms: single and multiple operator, manual and automatic, portables and stationary types.

Atomic Hydrogen and Helium Arc Welding

Two special types of arc welding equipment are atomic hydrogen, (an AC arc) and helium arc or "Heliarc" (a DC arc). Each of these depends on a special use of a gas. In the atomic hydrogen process a stream of hydrogen is discharged into the arc. This gas is dissociated (the H_2 molecules are broken up into individual atoms) and considerable heat from the arc is absorbed; when the resulting atomic hydrogen flame comes in contact with the material to be welded, the dissociated hydrogen recombines, liberating the energy previously absorbed. Thus, heat is given up right at the spot where it is



most needed (at the surface of the parts to be welded), hence a tremendous localized heat is developed. Aluminum alloys, high nickel and high chromium alloys can be welded by this method.

In the Heliarc process a tungsten electrode is used and the DC arc is enveloped in a protecting atmosphere of helium; by this method many magnesium alloys (cast or wrought), hitherto unweldable, can now be satisfactorily joined. By changing polarity and substituting a graphite electrode for the tungsten, some formerly non-weldable ferrous materials (such as sheet stainless steel and other alloys) can be welded.

Resistance Welding

The second general method of electric welding, resistance welding, includes the following processes: upset-butt, flash-butt, spot, projection and seams; these generally are AC processes.

Upset-Butt Welding—Upset-butt welding is performed by pressing two pieces of metal together so that their junction forms the point of highest resistance to the passage of an electric current; this resistance to the passage of the current causes the ends of the work-pieces to heat. By allowing sufficient current to flow so that these ends are heated to a plastic state, and then increasing the pressure holding the ends together, an upset weld is formed.

This type of welding is not generally used (having been superseded by flash welding) because the ends of the parts to be joined must be specially machined for a smooth fit before welding. After welding, the large upset is sometimes a disadvantage as it must be removed by mechanical means.

Flash Welding—Flash welding as used for joining metallic parts end to end, such as welding sheets of steel together to form one continuous strip, the welding of circled strips or bars to form rings, the welding of tubular sections end to end, and the welding of sheet stock to form tubing. To weld by this method, two parts are placed end to end with a narrow air gap between them (See Fig. 1). The passage of the current across this gap creates a "flashing" action. That is, uneven edges of the adjacent pieces are quickly burned away but the heating effect of the current — this continues until both surfaces have reached the fusion point. Then, with the sudden application of pressure, the two pieces are forced together, forming a strong weld. The resulting upset is small.

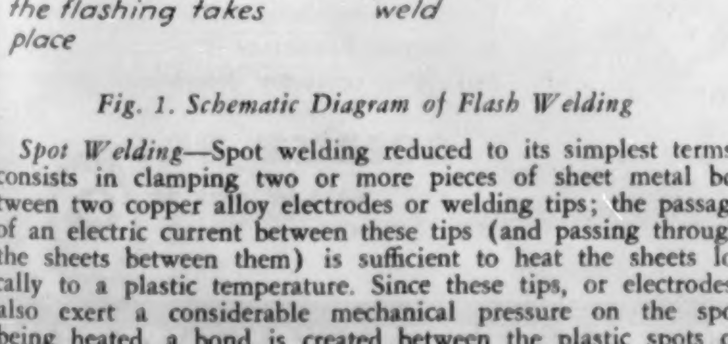


Fig. 1. Schematic Diagram of Flash Welding

Spot Welding—Spot welding reduced to its simplest terms, consists in clamping two or more pieces of sheet metal between two copper alloy electrodes or welding tips; the passage of an electric current between these tips (and passing through the sheets between them) is sufficient to heat the sheets locally to a plastic temperature. Since these tips, or electrodes, also exert a considerable mechanical pressure on the spot being heated, a bond is created between the plastic spots of the sheets. This is shown schematically in Fig. 2.

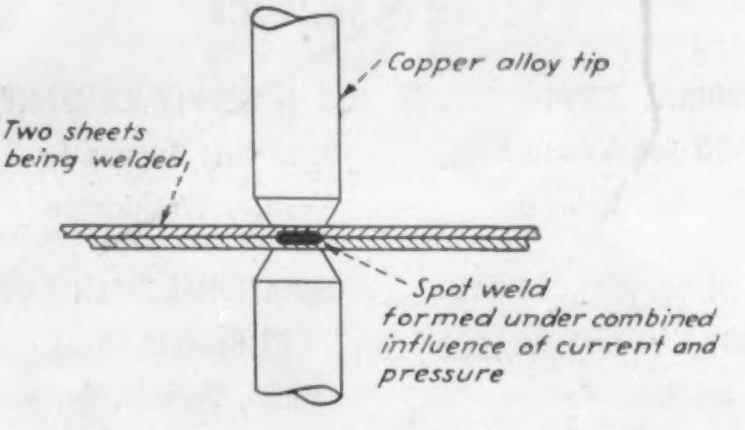


Fig. 2. Section Through Spot Welding Electrodes

Standard spot welders generally have a capacity for sheets of No. 30 gage (0.012") to 1" thickness. Portable and special purpose machines are often limited in capacity to a maximum sheet thickness of 1/8".

This is a very fast way of joining sheet metallic materials, and is used in automotive and aircraft plants as well as in many other sheet metal fabricating industries. The welds are strong and the only prior treatment required is a cleaning operation to remove grease, dirt and scale. No machining is required after spot welding.

Seam Welding—Seam welding is another important AC sheet metal joining process. This type of welding is usually restricted to mass production industries where straight or circular welds are needed. A seam weld is actually a series of overlapping spot welds. For a schematic diagram of seam welding, see Fig. 3. It can be seen from this diagram that instead of tips to carry the current (as in spot welding), wheels are used.

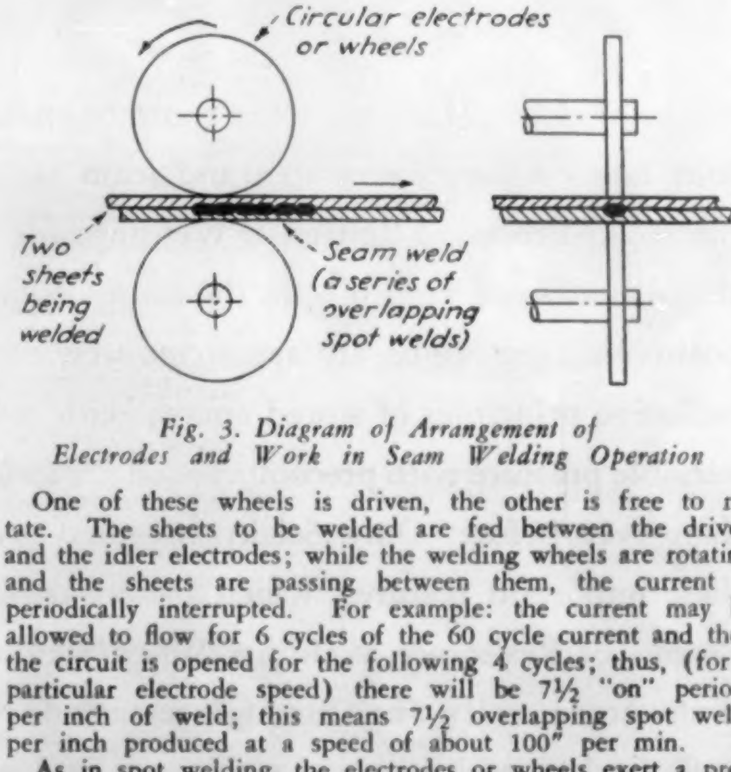


Fig. 3. Diagram of Arrangement of Electrodes and Work in Seam Welding Operation

One of these wheels is driven, the other is free to rotate. The sheets to be welded are fed between the driven and the idler electrodes; while the welding wheels are rotating and the sheets are passing between them, the current is periodically interrupted. For example: the current may be allowed to flow for 6 cycles of the 60 cycle current and then the circuit is opened for the following 4 cycles; thus, (for a particular electrode speed) there will be 7½ "on" periods per inch of weld; this means 7½ overlapping spot welds per inch produced at a speed of about 100" per min.

As in spot welding, the electrodes or wheels exert a pressure on the work forcing the spots of plastic metal (heated to plasticity by the passage of the electric current) into a strong, pressure tight weld.

This has been a very brief description of the more important gas and electric welding processes; a more direct comparison of these processes will be made on a forthcoming "Engineering File Facts" page.

Compiled by Robert S. Burpo, Jr.

NUMBER 6

MATERIALS AND DESIGN
Engineering Steels

Hardenability Notes

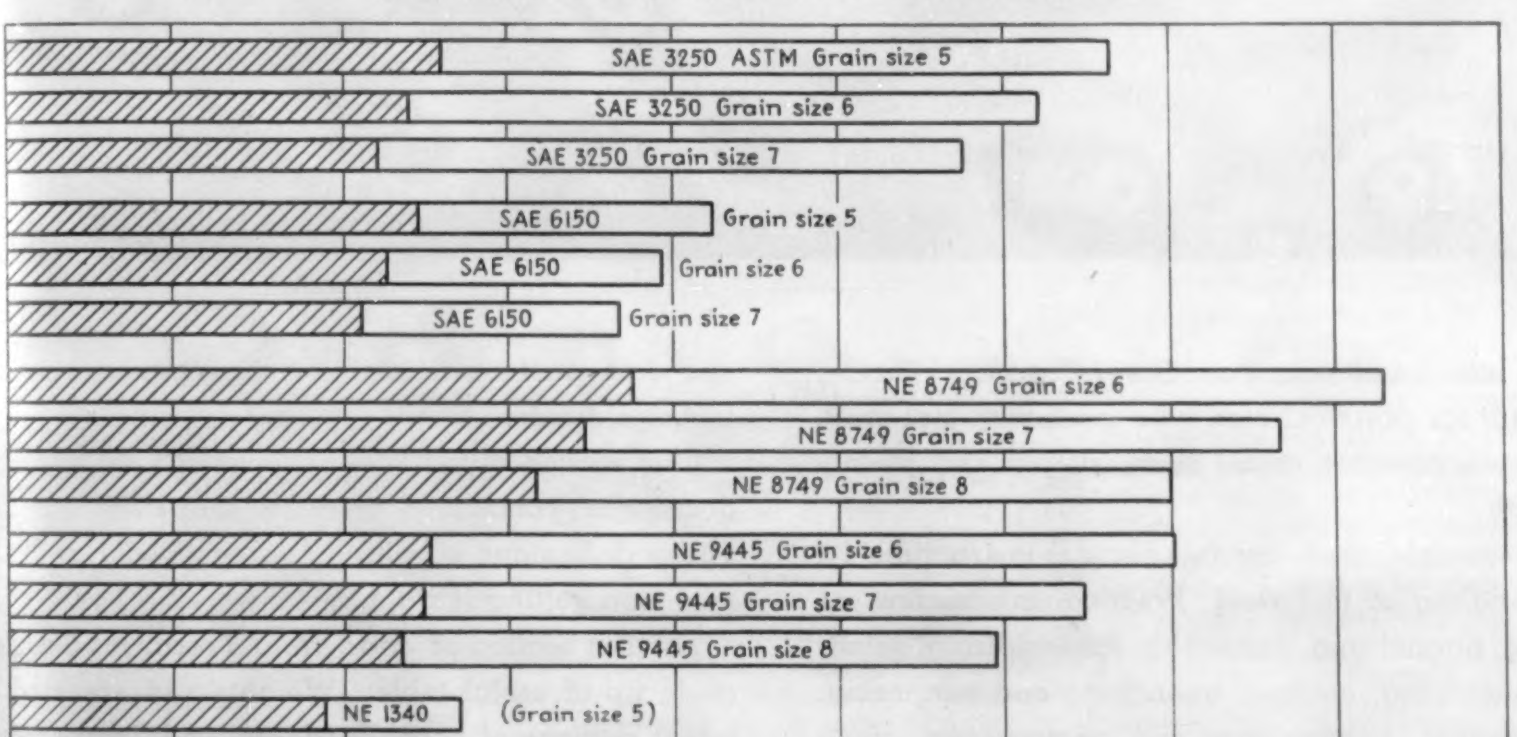
The term "hardenability" is used to designate the ability of a steel to harden easily and deeply. The reason that this term has received prominence when reporting information regarding NE steels is because of the ease with which hardenability tests can be made. (This test procedure has been standardized in ASTM Spec. A 255-42.) Hardenability tests, then, developed into a very rapid basis for comparing the SAE-AISI steels and the new NE group.

The tendency of some people to judge the NE steels solely on the basis of hardenability was not sound, as other information (such as impact strength, fatigue values, etc.) are also of importance when selecting alternates. However, hardenability data can be used for comparative purposes. If it is necessary to choose a low alloy alternate steel to replace one of higher alloy content, the hardenability of the standard and several possible alternate steels can be computed by Grossmann's method (Trans. AIME, Vol. 150, 1942) and compared; the steels with lesser depths of hardening can then be excluded from consideration.

As an example of this, the bar graph below shows the diameters of round steel bars that will just harden through to a minimum value of Rockwell C 45 under conditions of an ideal water quench as computed by Grossmann's method. The shaded parts of the graphs indicate the diameters that will just harden through (to Rc 45) when the chemical composition is on the low side of the specification; when the chemical composition is on the high side, the entire length of the graphs indicate the maximum diameters that will harden through for the three indicated grain sizes.

Since these data are based on ideal water quenches, (never attained in practice), they are for comparative purposes only.

Comparative Hardenabilities of Some Engineering Steels



Compiled by Robert S. Burpo, Jr.

METALLURGICAL ENGINEERING shop notes

High Production Milling

By Carlton Jones,
Yellow Truck & Coach Mfg. Co.

The "wrinkle" described here provided an increase by 33⅓ per cent in milling brake cross shaft levers, which are pieces about 6 in. long and 1½ in. at the thickest part. Previously, two of these pieces were milled at one time, having been loaded into the machine, worked on, unloaded. Then the cycle began again.

Now forty pieces are loaded into a special arbor developed by me, and the arbor is loaded into the machine. While these 40 are being milled, another arbor is loaded, ready for mounting in the miller, finally saving one third the former operation. Instead of .012 hrs. to mill one piece, it is now done in .008 hrs. The author received recognition from WPB for his application.

The upper photograph shows the older method of milling two levers; the lower, the newer, handling 40.

Most metal workers are too careless with files. After use they should be cleaned with a wire brush, wrapped up in paper and stored in a safe dry place, equal to a more expensive tool. Occasionally a sand blasting treatment is advisable. The best procedure is as follows: Grasp file by the handle and introduce it into the blast at the file tip, moving so that the stream works towards the handle. Remove from the stream completely and reintroduce at the tip. In all, make three passes. More would oversharpen the file teeth.

—Nicholson File Co.

Conservation of Welding Electrodes

by H. O. Westendarp,
General Electric Co.

Welding electrode manufacturers are already operating around the clock, seven days a week. Bare portions of electrodes have been reduced to a minimum to lower stub losses; coatings have been improved to reduce spatter loss. It is now up to the user of arc-welding to conserve electrodes, and the following 6-point program is suggested:

(1) Select largest diameter and greatest length electrode that can be applied successfully. This speeds up deposition rates of weld metal and makes for decided increase in electrode tonnage extruded per day.

(2) Joints must have a good fit-up. Excessive gaps are prolific wasters of metal.

(3) Use proper amperage for the job. Avoid excessive currents and long arcs. There is a current beyond which deposition rate is decreased and electrode consumption increased.

(4) Don't bend electrodes unless absolutely necessary. When bent, coatings are destroyed, with stub losses excessive.

(5) Produce true fillet welds having equal legs — all of a function of proper type electrode and welding technique.

(6) Use electrode down to point where full coating diameter ends.

Electrode inventories should be utilized and stub ends converted as rapidly as possible. Universal adherence to this program would mean 20 per cent more electrode saved. Alternating-current equipment can be obtained more readily than the d.c. type. In the manufacture of the former, less tooling and machine work are required, as well as fewer critical materials such as copper and steel.

Lubricating Wire Rope

Frequent lubrication of a wire rope prolongs its life indefinitely by sealing in the internal lubrication around each wire. Always clean thoroughly by a jet of air, steam or wire brushing. Allow to dry.

One method is the paint brush application. or with a rag or sheepskin. Where a heavy non-flowing lubricant is used, the worker applies lubricant to the palms of leather gloves, grasps the rope and slides up and down.

A trough or slush box is also employed, the rope being conducted beneath the liquid with sheaves and pulleys—over the edge of the box and one sheave, under the main sheave, and over the third sheave and out the trough.

—*Ropeology,*
Macwhyte Company

Stellite on Two Gage Faces

By Charles Trett,
Cadillac Motor Car Div.,
General Motors Corp.

The Cadillac tool repair department handles between 4,000 and 5,000 steel snap gages a month. We found that an ordinary steel gage held specifications only two hours when in constant use. With one surface treated with stellite, it would last three.

However, the author's scheme of treating both gage faces with stellite assures accuracy for as long as two days. We tried various devices to improve wearing quality of our gages. Carboloy was too tough and expensive to grind. Stellite proved satisfactory on one face, which was standard practice, though gages still came in for frequent repair.

Previously, when a snap gage wore below the allowed tolerance of .0005 in., repair men would grind off one face by .0015 in., weld on a coating of stellite and then grind and lap to required size. The treated surface then stood up better, but the opposite face was not improved.

The author conceived treating both gage faces with stellite, an idea which was simple enough. Results were that where two or three men were formerly employed on grinding and lapping the gages, now only one man was necessary. [The writer, a veteran tool man, has been awarded a Certificate of Production Merit by WPB at Washington.]

Heretofore at Packard Motor Co., industrial diamonds for dressing and keeping grinding wheels in trim have been taken out of the tool crib at the beginning of each shift and turned in again at the end. Many man-hours were wasted in the line-up of men. Now each grinder is charged with a diamond, which he keeps until need for resetting. Not only is time saved, but the diamond lasts longer, being kept at work on one specific job and not circulating for all sorts of work. This suggestion received an award from WPB, it being one of 33 to receive recognition from thousands of suggestions submitted.

—Harry L. Gielniak,
Packard Motor Co.

Detecting Hidden Flaws in Turbines

By J. L. Roberts & H. M. Dimond,
General Electric Co.

Where expensive machinery is involved, the detection of incipient failures allows the trouble to be corrected in time; otherwise, break-downs running into the thousands of dollars may result.

Turbine supervisory instruments in power plants have performed valuable service. Eccentricity records on the performance of a 40,000 kw. turbine led to the discovery of several broken buckets, thus averting disaster.

In another case, gradually increasing vibration indicated by supervisory records led to inspection and discovery of a crack developing in the generator field shaft. Supervisory instruments used in starting an 80,000 kw. turbine prevented wear on packings and bearings that would have decreased efficiency of operations. By indicating conditions of the machine during the starting sequence, the instruments told operators how much time to allow for working out excessive eccentricity and vibration.

Instruments record turbine conditions in terms of shaft eccentricity, bearing vibration, shell-expansion, speed and camshaft position. A non-recording interference detector is also available.

Firing a billet-heating furnace with charcoal has been done with excellent results by Cia. Brazilera de Usinas Metalurgicas, one of Brazil's principal steel plants. The billet furnace had formerly been fired with oil. A new front was built, with coal burners supported in its center. Everyone was surprised with the result. The flame can be regulated to any length and temperature, giving more regular operation than the oil and producing a scale-free billet.

—"The Whiting Founder",
Whiting Corporation

Welding Spiral Spring Over Wood

by Maximiliano F. Ore,
Patapo, Via Chiclayo, Peru

Where a spiral spring is broken, even if in several places, it can be welded together by a procedure somewhat off the regular routine. Shave down a wooden cylinder or rod in a wood lathe, or equivalent equipment, to the diameter of the interior of the original spiral spring. Then insert the wood into the spring, arranging the broken parts into their original location. Then weld the pieces together.

This idea was put in practice in Peru, when one of the springs in a gasoline engine, 80 h.p., which operates a rice mill, broke in several places. The wood was turned down to 2 1/16 in. diam., 12 in. long, the parts being joined by "Lightweld".

—*The Stabilizer*
Lincoln Electric Co.

Heights of tables in assembly departments of aircraft and similar plants should be of the same level to avoid necessity of lifting assemblies from one level to another. With all on one level, assemblies can be slid across space to an adjoining table.

—Paul Hegenbarth, Wright Aeronautical Corp., Cincinnati.

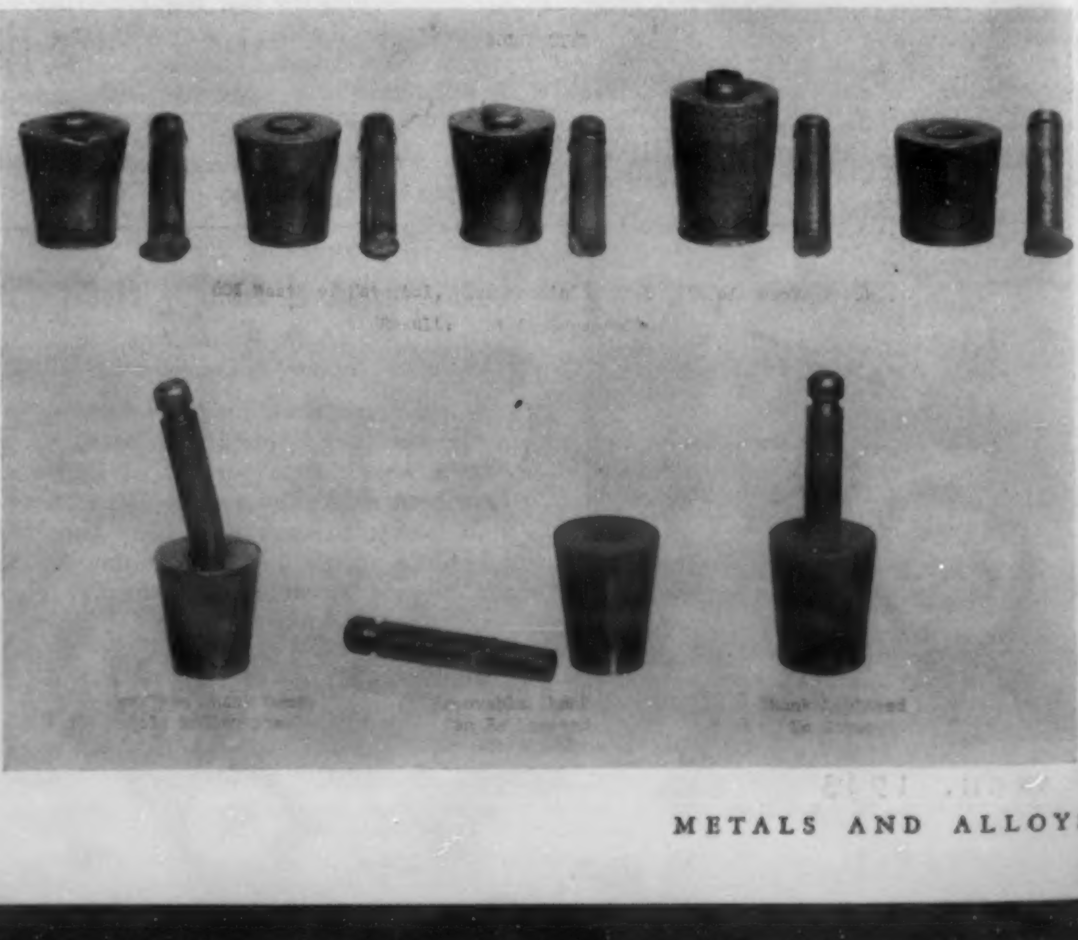
Removable Shanks in Rivet Squeezer Sets

By John Glowe,
White Motor Co., Cleveland

We devised a method for salvaging rivet sets in the form of a removable shank for use in squeezer sets for squeezing rivets. Formerly, difficulty was experienced with shanks breaking where the head starts.

We demonstrated that these could be repaired by machining a tapered shank and inserting it in a hole drilled in the head. The shafts are now replaced as they break, without damage to the expensive part of the tool, the head.

[The writer was given the Award of Individual Production Merit by the War Production Board for submitting this idea. —Editor.]



Metallurgical Engineering Digest

1 Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electro-refining. Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories. Melting and Manufacture of Non Ferrous Metals and Alloys. Soaking Pits and Other Steel-Mill and Non-Ferrous Mill Heating Furnaces. Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice.

2 Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings. Molding, Core-Making, Gating and Risering, etc. Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials.

3 Metal-Working and Treating

Die Casting. Powder Metallurgy. Drop, Hammer and Upset Forging. Press-Forming, Drawing, Extruding and Stamping. Machining, Grinding and Polishing. Hardening, Tempering, Age-Hardening, Annealing and Malleableizing. Carburizing, Nitriding and Surface Hardening, Heating Furnaces, Refractories, Fuels and Auxiliaries. Welding, Flame-Cutting, Hardfacing, Brazing, Soldering and Riveting. Cleaning, Pickling, Degreasing and Sandblasting. Electroplating, Anodizing, Galvanizing, Metal-Spraying, Coloring, Buffing and Organic Finishing.

4 Materials and Engineering Design

Engineering Properties of Metals and Alloys. Resistance to Corrosion, Wear, Fatigue, Creep, etc. Engineering Design Problems of Specific Industries and Products. Selection of Metals, Metal-Forms and Fabricating Methods. Non-Metallics in the Metal Industries. Applications of Individual Materials. Conservation and Substitution.

5 Testing, Inspection and Control

Specifications. Physical and Mechanical Property Testing and Inspection. Routine Control and Instrumentation. Radiography and Magnetic Inspection, Spectrographic and Photoelastic Analysis. Corrosion- and Wear-Testing. Examination of Coatings. Surface Measurements. Metallographic Inspection and Technique.

1 Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories • Melting and Manufacture of Non Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice

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Remelting Cartridge Cases

Condensed from "Metallurgia"

A recent report by John Rae, Jr., is based on an investigation of the use of fired 0.303 in. cartridge cases as scrap in the production of some extrusion brasses.

Before firing, antimony to the amount of 1 per cent of the weight of the unfilled case, in the form of antimony sulphide, was present. There was a considerably smaller content of mercury.

Tests were carried out under full production conditions, the heats being melted in half-ton low-frequency induction furnaces and poured into 6¾ in. diameter water-cooled molds. The billets were extruded under normal conditions at a suitable temperature. Standard war-time mixtures containing a large percentage of scrap were used, the cartridge cases replacing copper and spelter as far as possible. Comparative heats were made without the cartridge cases.

Added antimony was introduced after the melt in the induction furnace had been skimmed. Rods were tested in the "as-intruded" condition, except in the case of drawn leaded brass, the drawing of which was carried out cold. Test-pieces were taken from the middle of the rods. Three "straight" brasses, three typical leaded brasses, and a naval brass were used.

Results show that antimony is the element responsible for the impairment of physical properties. Mercury, suspected in the past, is not the cause. Because of the low boiling point of the latter, any not volatilized on firing, is reduced during the muffling process, and entirely lost in remelting.

The detrimental influence of the small quantity of antimony is confined to the impact values and to the cold-bending properties. The elongation and tensile strength are little affected except in the case of 62:38 brass.

Conclusions are that the use of fired cartridge cases should be avoided in "straight" copper-zinc alpha-beta brasses, especially 62:38 quality, as they have a definite embrittling effect, the properties of resistance to shock and cold riveting being most detrimentally affected.

In leaded brasses, 10 to 20 per cent of cases can be safely used with very slight impairment of properties if no other antimony-bearing material is used in the mixture.

In 62:37:1 naval brasses, the one alloy in which the effect of the antimony is negligible, 40 per cent can be used. A brass rod, conforming to B.S.I. Specification No. 218, made with 30 per cent of cases has been tested with satisfactory results for the production of fuses. The susceptibility of the leaded brasses to season-cracking is not increased by the use of cartridge cases.

The elongation of leaded brass rods is drastically reduced by the presence of 0.02-0.10 per cent Sb. No detrimental effect from antimony has been noted on the hot working properties of any of the alloys investigated and no difference in machinability has been observed.

—*Metallurgia*, Vol. 26, Nov. 1942, pages 10-11.

Precision Strip Rolling Mill

Condensed from "Steel"

This cold mill was developed in Europe, where several units for rolling strip 30-50 in. wide were in operation sometime before the outbreak of the present war. One unit is in operation in the Chicago district at present.

Results being obtained include strip true to 0.0001 in. across its width and 0.0002-0.0003 in. lengthwise, with smooth edges, no crown, and no camber. The mill reduces strip to gages finer than 0.003 in. without intermediate annealings even when working on stainless and other alloy steels. Such steels are not brittle and have good ductility.

Upon annealing, the elongation exceeds that of similar material produced on conventional mills, where several intermediate annealings are necessary. The strip is flat and generally needs no roller leveling. Output is high.

Heavy reductions on work-hardened material are taken easily. For instance, a last pass from 0.006 to 0.003 in. is not unusual. The mill is less expensive than conventional equipment and its operating costs are lower. It weighs 26-50 per cent of a corresponding 4-high mill.

The characteristic of this mill lies in a new principle of having the backing elements take up the roll separating forces right where they are generated and carry them over the shortest distance to the solid one-piece housing.

Conventional backing rolls pick up the roll separating forces along their line of contact with the work rolls and then carry them to their necks and bearings lying outside of the width of the strip.

For lighter operations, such as for nonferrous metals and skin-pass mills, a single-backing arrangement is used. Each work roll contacts 2 rows of bearing rings, each row mounted on one shaft. Between each 2 bearings (or each 2 pairs of self-alining roller bearings) there is a "saddle," so that the roll of pressure, as exerted by the work

roll on those bearing rings, is transmitted at frequent intervals to the rigid housing.

With small work rolls, the strip has to slip over only a short contact length as against the long contact length with the large diameter work rolls of conventional mills.

Still more important, the roll bite with small work rolls is more open, causing even less friction and not interfering appreciably with the beneficial effect of the back tension. Power consumption on the Sendzimir mill is about 30 per cent less than on conventional mills, when rolling ordinary low-carbon steel. The small work rolls undergo much less wear.

Either high-grade alloy steels or tungsten carbide can be used for the work rolls. Since it is preferable to drive the intermediate rolls, the work rolls have no torque to transmit.

Tungsten carbide rolls will preserve a mirror-like finish for a long time. They also flatten appreciably less at the contact area, because their modulus of elasticity is about twice as high as that of steel. Roll-flattening is not much of a problem with small diameter work rolls.

—T. Sendzimir, *Steel*, Vol. 111, Nov. 30, 1942, pages 64, 67-68, 74.

Refractories for the Bessemer

Condensed from "The Iron Age"

Bessemer refractories have an extremely rapid rate of wear of the bottom, and an enormous potential output in relation to the size of the installation. The rapid production rate offsets the rapid wear on the refractories, which cost 20 cents per ton of steel as compared with $1.00 for the open-hearth. In both the acid and bessemer processes, the molten iron from the blast furnaces comes via a mixer to the converters, and the amount of scrap used is small.

The lining of the mixer varies with the process, being generally of silica brick for the acid bessemer, and magnesite for the basic. For silica brick, a soft quality is preferred, due to the reduced risk of thermal spalling and the tight joints associated with after expansion. Most basic mixers are lined with blocks made from Australian magnesite, and should be adequately fired to reduce the shrinkage.

Below the metal level little trouble occurs but at the slag level, shrinkage may be a cause of premature failure due to blocks becoming loose and falling out. Where magnesite bricks are backed by insulating brick, the high conductivity of the magnesite compared with that of the insulating brick results in an interface temperature of only 125 deg. F. or so below that of the working face. Hence although the operating temperatures are comparatively low, slag and even metal may penetrate into the blocks.

Sandstone and Dolomite as Linings

Vessels of most of the American converters are lined with sandstone. In British acid converters the lining is generally of soft fired silica brick. Raw quartz in these linings probably changes to cristobalite, at least in surface layers, and considerable expansion occurs. In some plants

the lining is coated before use with a layer of 2 or 3 in. of ganister.

The basic bessemer vessel is lined with tarred basic dolomite calcined at high temperature and may be in the form of block or a monolithic ramming. The amount of tar used is between 5 and 7 per cent, although the optimum amount should be used.

Material for the tuyere is dry mixed in pan mill, pugged with water, extruded, placed in lubricated brass mold and pierced. It is dried for several days and fired to about 2550 deg. F.

The space between tuyeres is filled with pre-fired fireclay blocks. Blocks are generally 24x12x3 in., but equally good results have been obtained with triangular fillers.

Where a wet slurry is used to fill the gaps, it generally consists of ⅔ ganister-clay mixture and the rest fireclay. Rammed disks are more often made with a firebrick grog bonded with a raw clay. Raw clay and grog are ground in a pan mill. Water content is about 8 per cent. Drying temperatures must be between 400 and 900 deg. F.

Life of Bottoms

Life of a bessemer bottom varies from 10 to 40 blows. Sections cut through acid bessemer slag suggest that a large amount of wear on the ramming is due to "stoning," the loss of large particles of grog due to attack on the surrounding bond.

Refractories for the basic bessemer process are prepared from dolomite and water-free steelworks tar. Proportions of tar is about 7 to 12 per cent and of naphthalene about 3 per cent.

Basic bessemer bottom can be built using magnesite tuyeres and ramming the interstices with tarred dolomite, but more often the plug is a monolithic structure, the holes being evenly spaced.

It is claimed that a 5 per cent improvement in bottom life can be obtained by using preformed tuyeres of tarred dolomite. With such bottoms 40 to 50 tuyeres are used 7.1 in. in diameter and 29.5 to 37.4 in. high.

Typical life for a 25-ton basic converter is 40 to 50 blows. For a 40 to 45-ton a life of 64 charges for the bottoms and 380 for the side walls with the diameter of bottom, 10 ft.; thickness, 3 ft. 3 in.; 348 holes; hole diameter 0.57 to 0.59 in.; and blowing area of 2.7 sq. in. per ton of metal.

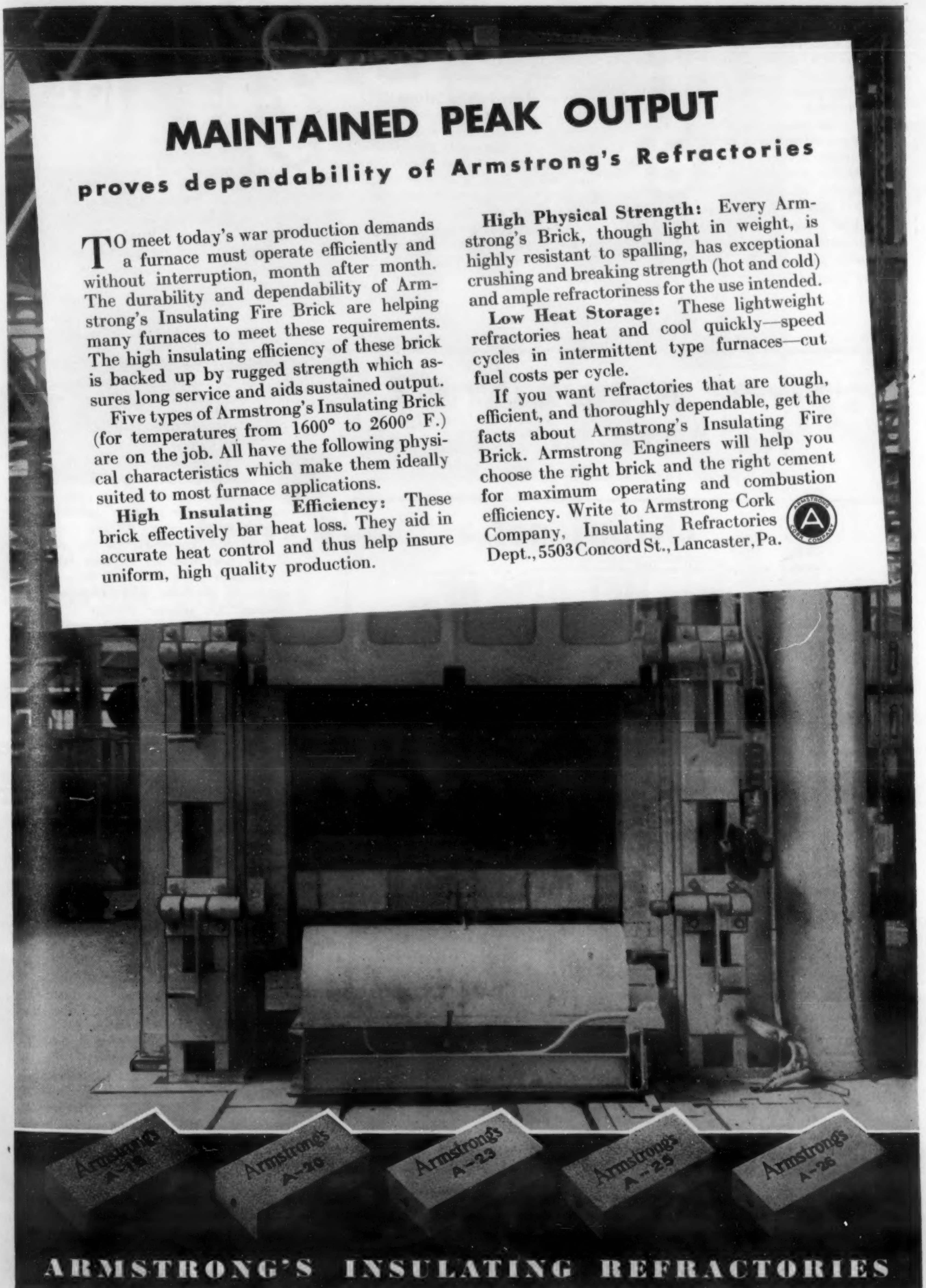
—J. H. Chesters, *Iron Age*, Vol. 150, Nov. 5, 1942, pages 43-48; Nov. 12, 1942, pages 58-64.

Blast Furnace Stock Distribution

Condensed from
"Blast Furnace and Steel Plant"

Distribution of the materials on the small bell into peaks is affected greatly by the diameter and height of the small bell hopper. The narrower and taller this hopper is, the less pronounced will be the peaks. However, a tall hopper results in a considerable amount of coke breakage because of the greater drop of material from skip to bell.

Opinion is that the additional coke breakage is more undesirable than the less per-


MAINTAINED PEAK OUTPUT
proves dependability of Armstrong's Refractories
TO meet today's war production demands a furnace must operate efficiently and without interruption, month after month. The durability and dependability of Armstrong's Insulating Fire Brick are helping many furnaces to meet these requirements. The high insulating efficiency of these brick is backed up by rugged strength which assures long service and aids sustained output.
Five types of Armstrong's Insulating Brick (for temperatures from 1600° to 2600° F.) are on the job. All have the following physical characteristics which make them ideally suited to most furnace applications.
High Insulating Efficiency: These brick effectively bar heat loss. They aid in accurate heat control and thus help insure uniform, high quality production.
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If you want refractories that are tough, efficient, and thoroughly dependable, get the facts about Armstrong's Insulating Fire Brick. Armstrong Engineers will help you choose the right brick and the right cement for maximum operating and combustion efficiency. Write to Armstrong Cork Company, Insulating Refractories Dept., 5503 Concord St., Lancaster, Pa.
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ARMSTRONG'S INSULATING REFRACTORIES

fect distribution on the small bell. Experience with two furnaces at the Inland Steel Co. confirms this. One furnace has a tall, narrow hopper, which gives flatter peaks and better distribution, while the other, in spite of its more pronounced peaks and poorer distribution, has always operated more uniformly and produced greater tonnage.

The McKee revolving top has been the most popular of the different types of mechanical distributors used. It distributes the stock to predetermined zones by means of a motor-driven revolving hopper combined with an automatic control. Materials are dumped into a small bell hopper through a stationary receiving hopper. After each skip is dumped, the small bell hopper is rotated a fixed number of degrees in multiples of 60 deg. F.

Function of the Selector Setting

The number of times the top is rotated at each angle is known as the selector setting. To determine the proper selector setting, a series of observations were made on a furnace at the Inland Steel Co. Filling orders used consisted of ore, stone, coke, ore, coke, and coke, with an empty skip or a skip of miscellaneous ferrous material at the beginning of the first charge and every third charge thereafter. This prevents the constant carrying of the same materials in the same skip. The big bell was dumped after the first and third skips of coke in each charge.

The control of the rotating hopper provides for any number of skip loads from 0 to 9 to be distributed at 6 equi-distant stations on the large bell. The selector setting governs the number of times the rotating hopper will revolve at each of the following angles: 60, 120, 180, 240, 300, and 0 deg. Twelve charges were thought to be enough to give a good idea as to uniformity of stock distribution.

Observation of the position of the raw materials as they dropped from the skip into the small hopper showed that each type of material formed a definite peak. The location of the peak was determined by the skip in which the material was carried.

Assuming the plan view of the small bell to be vertical and divided into 6 equal zones numbered clockwise, with zone 1 being the lowest sextant to the left of the vertical center-line, ore carried in skip 1 formed a peak in zone 1, stone in zone 5, and coke in zone 6. Ore carried in skip 2 formed a peak in zone 6, stone in zone 2, and coke in zone 1. This condition was the same as that when the selector setting is at "0."

From this knowledge of the positions of the raw materials as they fell from the skips into the small bell hopper, their respective positions after rotations were tabulated for selector settings 0 through 9 as hypothetical cases and graphs were drawn. Reading of these indicated that selector setting 4 gives the nearest approximation to complete uniformity in distribution for this furnace.

For this setting, stone peaks from 12 charges are distributed as 3 skipfuls in zone 1, 2 in zone 2, 1 in zone 3, 3 in zone 4, 1 in zone 5, and 2 in zone 6. Ore had 4, 3, 6, 2, 4, 5 peaks in zones 1-6, respectively, while coke is distributed in 7, 6, 6, 5, 6, 6 divisions respectively.

Experience with Other Furnaces

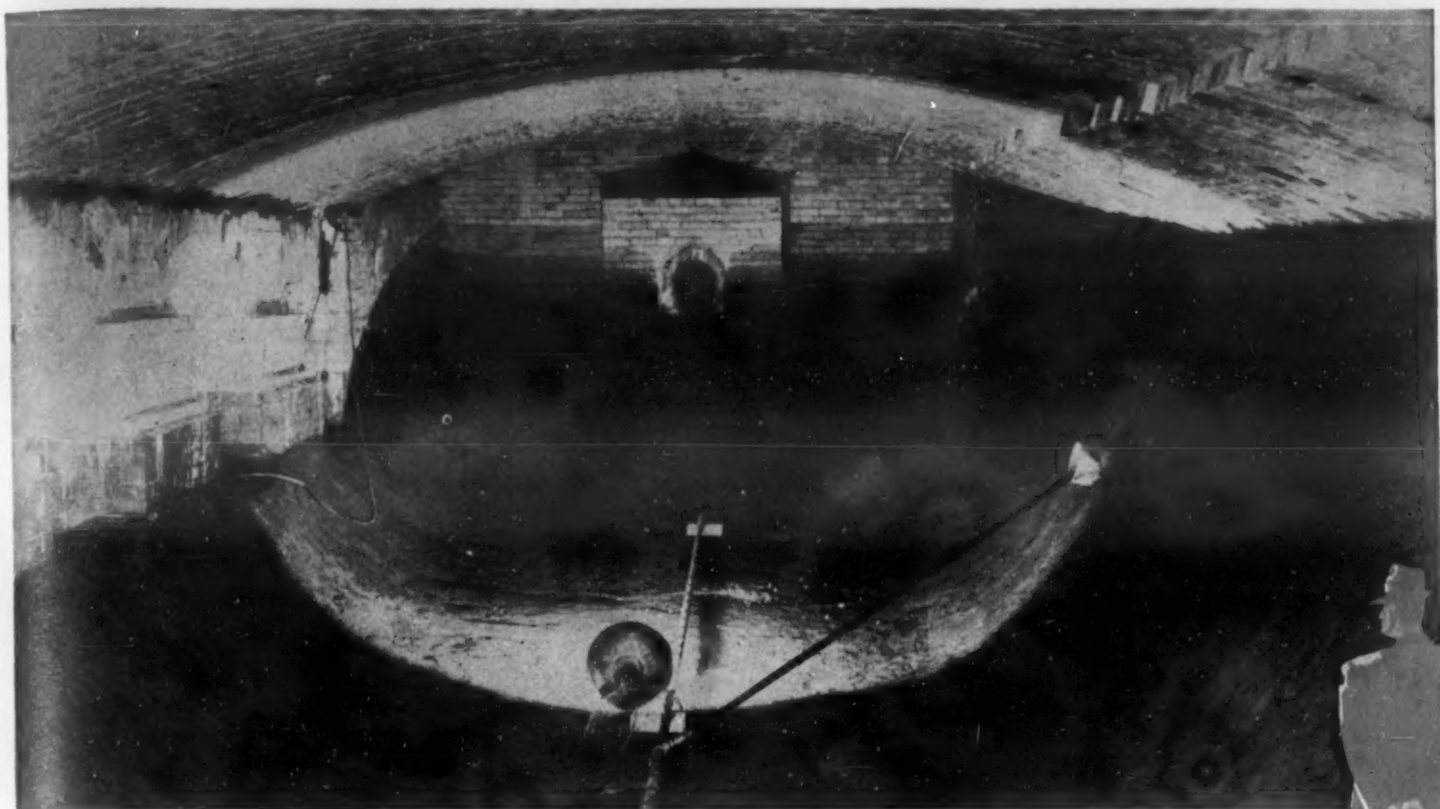
Observations on other furnaces showed that the peaks form definite patterns, but not necessarily the same pattern for all furnaces. Differences in design of the top, size, and filling orders of other furnaces necessitate a special study to determine the correct selector setting of each furnace's rotating top.

One day, this furnace was filled for 12 hrs. with no rotation taking place because of the failure of a key on the shaft driving the limit switch on the top of the furnace. The resulting poor distribution caused a sharp rise in sulphur for 2 casts. The actual result from lack of rotation seems to confirm the theoretical one.

To insure a periodical check on the movement of the revolving distributor, a recorder was devised that is activated by a reduction gear meshed with the "bull" gear.

Other factors that influence distribution are improper seating of the small bell, swinging of the big bell in its operation, and presence of too much water on some of the ore.

—Charles M. Squarey, *Blast Furnace & Steel Plant*, Vol. 30, Oct. 1942, pages 1131-1136.



A completed all-Ramix hearth, ready to heat up and prepare for charging.

141 more heavy bombers for Tunisia from ONE RAMIX hearth job

HERE is more proof of the value of Ramix in the production of steel for war:

Last October an open hearth shop in the Midwest installed its fifth successive all Ramix bottom. The entire cost of the hearth—including labor, fuel and refractory—was $7,855.80. This was 10% less than the cost of a conventional magnesite-and-slag hearth that had been installed in a similar furnace of the same size at this shop just a year earlier.

While this cost reduction is remarkable enough, a more significant saving was that made in construction time. It had taken 330 hours to burn-in the old type bottom, but the modern one of Ramix was rammed, heated up and made ready for its first charge in only 138 hours.

This time saving of 192 hours—attributable to the use of Ramix—enabled the furnace to begin producing steel 8 days ahead of time. In these 8 days the furnace made 2112 tons of steel—enough extra steel to manufacture 141 four-engine bombers or 56 medium tanks to speed up the 1943 Allied Victory program.

Ramix is one of a complete line of basic refractories now at your service. Ready, also, to assist you with your refractory problems, are Basic Service Engineers—expertly trained men, long experienced in open hearth practice, anxious to help you get maximum tonnage from your furnaces at lowest possible refractory cost.

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2 Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating and Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials

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Magnesium Foundry Practice

Condensed from "Foundry Trade Journal"

This is extracted from an entry to a short paper competition, organized by the Middlesbrough branch of the Institute of British Foundrymen.

Magnesium is melted in low carbon steel pots heated by means of gas or oil. A large amount of very fluid flux is used, a suitable composition being 60 per cent magnesium chloride, 40 per cent sodium chloride, which also acts as a solvent for oxides. Each piece of magnesium must be entirely covered by the flux before it starts to melt.

For 300 lbs. of metal about 40 to 50 lbs. of flux is first charged. After melting, the charge should be given a thorough puddling with a small hand ladle so as to bring the metal and flux into intimate contact. Then the metal is allowed to stand for several minutes to allow the impurities to settle out.

A suitable casting temperature is about 100 deg. C. (200 deg. F.) above the melting point of the alloy, usually of the order of 680 to 750 deg. C. (1250 to 1380 deg. F.) Another flux is compounded from 28 per cent magnesium fluoride and 72 per cent anhydrous magnesium chloride. This has the property of hardening to form a bridge across the top of the crucible. This is pierced to allow satisfactory pouring.

Oxidation is minimized by milling sulphur with sand. This substance is also dusted on the face of the mold, and on to the stream of the metal. Cores are made of an open silica sand with an oil sand binder, with sulphur added. The surface of the casting can be improved by smoking the mold face by means of an acetylene flame. The metal should enter at the bottom of the mold, the most satisfactory way being by means of a horn runner.

Chills are used extensively where it is not possible to get a feeding head. The castings have a great tendency to pipe. The castings have a high degree of notch-sensitivity.

For molding, a high permeable silica sand bonded with about 5 per cent colloidal clay, and containing about the same percentage of water is used. All molds for sand cast magnesium must be dried, and oxidation of the molten metal by the reaction with moisture is minimized by dusting sulphur on to the stream of metal poured from the ladle.

This process lends itself very well to the die-casting, and for this purpose the dies are preferably preheated to 350 deg. C. (660 deg. F.) and dressed with French chalk, sodium silicate, and water.

—J. Ladhams, *Foundry Trade J.*, Vol. 68, Dec. 10, 1942, page 342.

Steel Castings From Rotary Furnaces

Condensed from "Foundry Trade Journal"

At the Cincinnati Railway Works, in 1868, S. Danks produced wrought iron for rails in a large coal-fired refractory-lined drum, which rotated about a horizontal axis and rested upon permanent bearings. The basic lining of powdered iron ore and lime was applied as a paste in sections, and afterward dried and heated.

The present paper outlines the production of steel at Crewe Locomotive Works in a Sesci furnace something like that of Danks, but operating with an acid lining at temperature nearly 500 deg. C. (900 deg. F.) higher than his. For many years the L.M.S. Railway Co. has aimed at the utilization of the maximum amount of its own scrap. It has obtained satisfactory results with pulverized-coal-fired installations. For the manufacture of steel castings a Tropenas converter plant and a 12-ton acid open-hearth plant had hitherto been employed.

The decision was made about 1932 to install two Sesci furnaces, the ultimate aim being to develop a melting technique analogous to the crucible process. This requires neither pig iron nor a boiling procedure, and generally relies for the production of killed steel on the content of manganese.

The 5-ton non-reversing furnace, made under the Sesci-Garreau patents, consists of a horizontal cylindrical barrel about 10 ft. long and 7 ft. 8 in. in external and 5 ft. 2 in. in internal diameter, terminating at each end in a truncated cone to give an overall external length of about 15 ft. 4 in. It is built of boiler plate with heavy reinforcements.

One end of the furnace is fitted with a mixing chamber and the Sesci coal burner. The exhaust gases escape from the other into a movable head leading by a downcomer to a metallic recuperator. A by-pass is provided so that any proportion of the hot gases can go direct to the chimney, and by this regulation the combustion air is preheated to within limits of 400 to 600 deg. C. (750 to 1100 deg. F.) as temperatures above 600 deg. C. (1100 deg. F.) would cause combustion in the mixer and destroy the grid.

The movable head may be displaced in a direction at right angles to the furnace axis, so as to permit of charging and sampling. The barrel is fitted with two cast iron pathways. Complete rotation of the furnace can be made in both directions, with automatic reversal. The fuel supply consists of bituminous coal of about 30 per cent volatile matter. When the recuperated combustion air has reached a temperature approaching 200 deg. C. (400 deg. F.) powdered anthracite is gradually substituted for bituminous coal. The sulphur pick-up during steelmaking amounts to 0.02 per cent maximum. Operation, quality of steel and lining material are also discussed. Paper is supplemented with two appendices. Appendix A—"A patching Process for Sesci Furnace Linings" by T. Fletcher and Appendix B—"Tests on Refractory Lining Materials" by J. N. Bradley.

—F. A. Lemon and Hugh O'Neill, *Foundry Trade J.*, Vol. 68, Dec. 3, 1942, pages 295-300; Dec. 10, 1942, pages 325-330.

Blind Risering for Sound Castings

Condensed from "The Foundry"

Shrinkage is localized in the hottest section at internal angles forming a partial vacuum at this point if casting is not gated and risered properly. Atmospheric pressure acts equally upon all external surfaces. This pressure is about 15 lbs. per sq. in., and since casting skin at internal angles is weak, it is ruptured and the partial vacuum released.

Common place for this internal angle type of defect is where an ingate joins a casting. A cavity is often found at that point and this cavity has an opening through the outside wall of the casting. Risers are used on castings to compensate for liquid and solidification shrinkage and the movement of liquid metal out of the risers into the casting is the result of force of gravity, or liquid head.

Effect of Atmospheric Pressure

The less obvious but even more important force of atmospheric pressure is always present, tending to prevent the formation of any degree of vacuum within the solidifying mass. If a continuous skin is allowed to form over the riser and exclude atmospheric pressure from the liquid, the system will work in reverse and the casting will tend to feed the riser.

In cases of opposing forces the direction of greatest force can be determined by taking the difference between the force due to gravity and that due to atmospheric pressure. In cases where a solid wall of metal forms over the entire casting, atmospheric pressure will be withstood until shrinkage has formed a partial vacuum within the mold sufficient to provide a difference in pressure between the inside and outside of the casting which exceeds the strength of the solidified shell, when it will either collapse or puncture at its weakest point to relieve the partial vacuum.

Since discovery of a means for keeping blind risers open to the atmosphere has popularized their uses, and since an ever increasing number of castings are

made by this method, typical blind risers will be taken up.

A casting 2x4x10 in. is representative of a valve flange. Casting is about 5 in. higher than top of the blind head. In general the mass of the flange is great enough to require a blind head nearly as high as the part it is to feed.

As soon as the mold is filled, the metal loses temperature to the sand and a skin quickly forms at mold-metal interface. As temperature continues to drop, more metal solidifies forming a vacuum within the solidifying mass. Skin forming on all parts is impermeable except at the desired spot on the riser.

Atmospheric pressure acts on the metal in the blind riser forcing it into the casting as it is needed to feed shrinkage. If solidification proceeds properly, each successive amount of shrinkage is compensated by additional fluid metal forced in from the riser. Several means can be used for keeping a blind head open. One is the use of thermit placed at the top of the riser has been found satisfactory.

Advantages of Blind Risers

Some of the advantages of blind risers are:

(1) Hotter feed metal in the risers as a result of being able to gate through them into the casting. Also last which is the hottest is in the riser; (2) Bottom gating is fully practical thereby reducing sand erosion and at the same time promoting proper heat gradients; (3) Saving in cleaning costs by being able to put the risers on flat surfaces and at any position necessary in the mold; (4) Increased yield through more economical feeding; and (5) More solid castings because blind heads can be placed wherever needed.

One important point in using blind risers at different levels is the same casting and depending upon the atmospheric pressure for their proper behavior, is that a particular zone of feeding must be relegated to each head. Atmospheric pressure is not a panacea for all gating and risering problems but it can be used to cause good or bad castings depending upon how well its principles are understood and applied.

—H. F. Taylor & E. A. Rominski, *Foundry*, Vol. 70, Oct. 1942, pages 74-77, 161-164.

Quality of Aluminum Castings

Condensed from "Die Giesserei"

In sheet metal the strength is generally the same in all directions; in strip, as a result of the rolling in one definite direction, different properties are obtained in the longitudinal and transverse directions. In forgings there are variations in properties with varying section because of varying degrees of working. In heat-treated alloys, the strength is less with thicker sections due to less effective quenching.

Even greater variations in properties can be observed in castings, depending on the casting conditions. With aluminum castings, the grain size, and hence the mechanical properties, are greatly influenced by the rate of cooling; the finer the grain, the greater is the strength.

Since the rate of solidification governs the grain size, the cross-sectional area of the casting and the conductivity of mold are important factors. Metal molds have better heat conductivity than sand molds, so that in general die castings have better mechanical properties than sand castings.

The pouring temperature has other effects in addition to influencing the rate of solidification; increasing the pouring temperature does not always give reduced strength, but actually increases the strength in certain alloys. This is mainly due to the beneficial effect of high pouring temperature upon the formation of blow holes.

If exact data are required concerning the strength of a casting, they can be obtained only by taking a test piece from the actual casting and thereby destroying it. Even so, the strength varies with individual castings, depending not only on the temperature of pouring but in the case of sand castings, also on the water content and the tightness of packing of the sand.

Only very seldom can a casting be cut up into pieces, and therefore, the determination of the mechanical properties is reduced to a test of the quality of the metal used. There are widely different opinions as to whether it is permissible to cast the test pieces separately or whether to incorporate them in the casting.

In view of the fact that any one cast-

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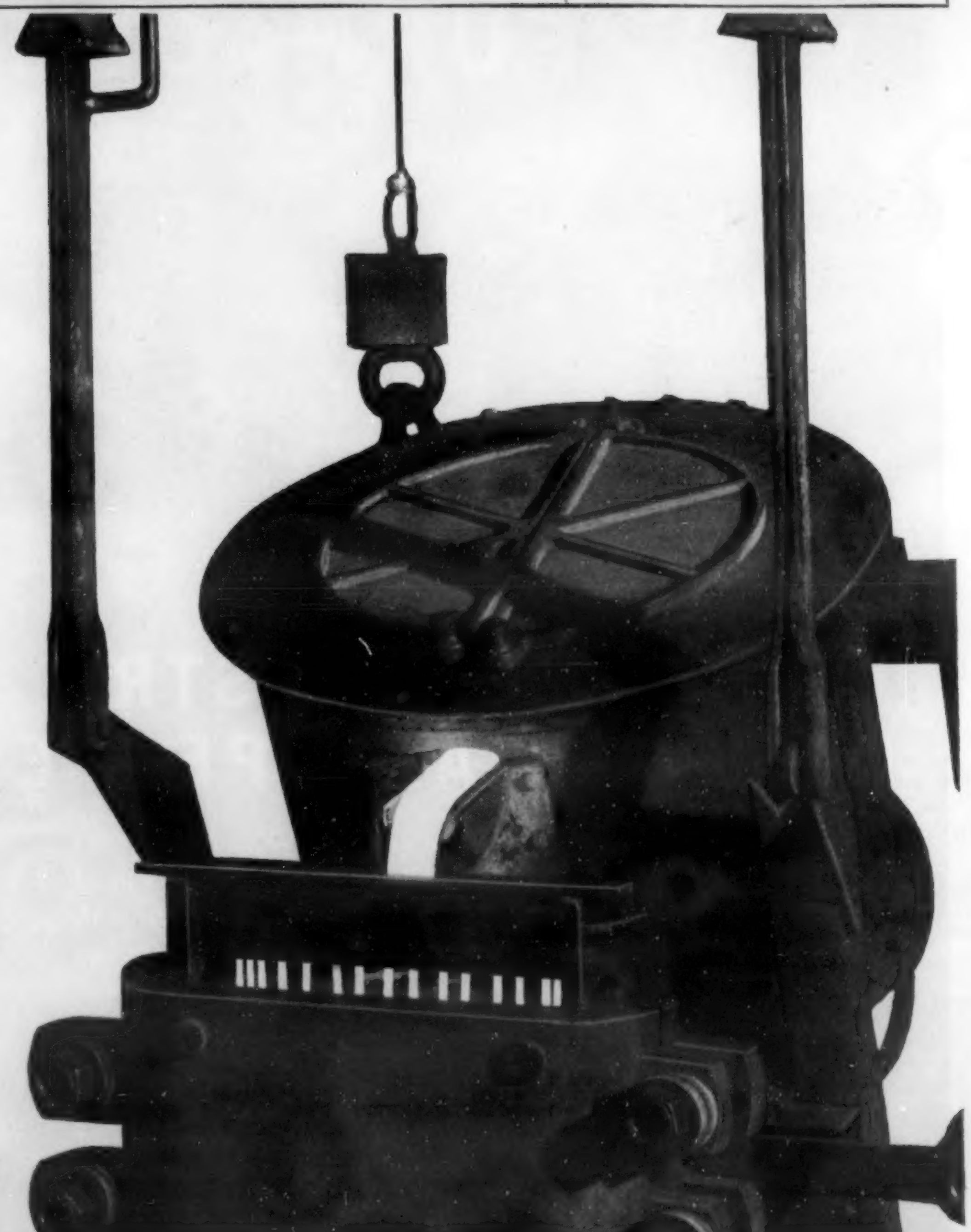

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in-one test piece does not represent the true strength of the casting, the separately cast specimen is usually preferred. The only drawback of this method is the danger of mixing up the test pieces; with suitable marking and reasonable care, however, this can be avoided.

If we realize that, in the first place, the test piece has to indicate the properties of the liquid metal at the time of casting, then separately cast test bars are to be preferred on account of their greater uniformity and reduced numbers. The mold used for the test piece must be similar to that used for the casting. This is particularly important because castings of widely different properties are obtained when the mold of the rate of solidification is altered.

—A. Von Zeerleder, *Giesserei*, Vol. 29, Jan. 9, 1942, pp. 7-10 (abstracted in *Engineers' Digest*, Vol. 3, Nov. 1942, pp. 365-366).

Reclaiming Core Sand

Condensed from "The Iron Age"

The processing method of the Wright Aeronautical Corp. consists of knocking out the molds over an apron picking conveyor. Chill, cores, rods, wires, etc. are picked out. Conveyor empties into a rotary breaker with screen having 1-in. holes.

Lumps 1 in. and under are carried over a magnetic pulley, which removes wires or nails remaining in the sand, and empties into bins. From here sand passes into the ring crusher, which further granulates it. Next it passes through a 30-mesh screen, and then it is run over a magnetic pulley that removes any iron oxide or small ferrous particles remaining. Next the sand is fed by a screw conveyor into a kiln at the rate of 3½ to 4 tons per hr.

The kiln rotates at 1 to 3 r.p.m., is oil fired, and is lined with wedge shaped refractory bricks. As sand progresses down the kiln in an oxidized atmosphere, its temperature is raised to between 1400 to 1500 deg. F. This temperature is adequate to burn off the carbon, and not too high to cause fusion or cracking of the sand grains. About 12 to 15 min. are required for the sand to pass from one end of the kiln to the other.

From the kiln the hot sand flows into a cooling unit. This machine is a Link-Belt Roto-Louvre cooler, and in addition to cooling the sand, removes secondary carbon. However, when sand enters the cooler at a high temperature, it comes in contact with air at room temperature and it absorbs a portion of the oxygen, causing a bleaching effect.

Color is a convenient empirical method of regulating the movement of the sand through the kiln and cooler. The purpose is to obtain sand as white as possible from the discharge end of the cooler.

Toward the end of the cooler a very fine water spray hits the sand, serving to cool it further. The volume of the spray is regulated by a thermocouple so that the volume of spray is directly related to the temperature of the sand. This prevents sand from leaving the cooler wet. When the sand enters the cooler it is about 1000 deg. F. and when it leaves it is about 150 to 180 deg. F. and free flowing.

Backing sand is made from 100 per cent reclaimed material, while in facing, reclaimed sand is used in the same proportions as new sand except that about 1 per cent more cereal binder is added.

In an emergency it has been found possible to use unburned reclaimed sand for backing. When unburned reclaimed sand is used, the cores have a tendency to brittleness and the grains lack cohesion. In some cases it is necessary to dilute such sand and also to use large quantities of binder.

Analysis of sand coming from a reclamation unit is determined by the type of sand going in. Screen analyses are made every shift, or more frequently if warranted.

The amount of carbon remaining in the sand after passing through this unit is about 0.5 per cent according to ignition tests.

With recirculation, it is possible to reclaim about 85 per cent of the sand going into the unit. Some loss is unavoidable in the form of fines and dust, and there is also a loss in conveying the sand through the various stages.

The economics of a reclamation unit are largely determined by the location of the plant with respect to the sand source.

—W. A. Phair, *Iron Age*, Vol. 150, Dec. 17, 1942, pages 43-48.

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Shell Forging Methods Compared

Condensed from "American Machinist"

Today shell production is probably provided as follows: Pierce-and-draw 55 per cent, upsetter 40 per cent, miscellaneous (bulldozing, Assel cross roll mill, etc.) 5 per cent. Comparatively speaking, there is little choice between the first two. All sizes of shell are forged by the pierce-and-draw method, while the upsetter is limited to smaller sizes, generally only up to and including 3 in. and 105 mm. Average rejects for both methods are 5 per cent.

Since the upsetter shapes the outside of the shell, considerable metal (20 per cent in some cases) is saved as well as machining. However, the upsetter requires a more thoroughly trained staff as maintenance is much more exacting. Since the work is divided among 5 or 6 tools, the wear of each is reduced, but the cavities of the shell are more liable to scratching. Tool life in the pierce-and-draw method is quite short, but the punches and dies are easily and cheaply made.

Production rates vary but a fair comparison would be an output of 175 shells (105 mm.) per hr. for two presses and one draw bench versus 160 shells for two upsetters. The pierce-and-draw set-up would require about 13 men versus 10 for the upsetters.

Shell steel of WD X-1335, X-1340 and X-1345 is used. These steels are quenched with an air blast to bring up to the specified 105,000 lbs. per sq. in. tensile, 70,000 lbs. per sq. in. yield point, 16 per cent elongation, and 45 per cent reduction of area. Except for trench mortar shell, these high sulphur, air hardening steels will shortly be abandoned in favor of straight carbon steels. For one thing, the returned scrap is building up the sulphur content at the steel mills. Also, a smaller crop is taken from straight carbon billets, thus resulting in a higher rate of output at the steel mills, to say nothing of the decreased time required for chipping, grinding and other preparations for rolling. Last but not least, manganese will be saved.

—J. B. Nealey, *Amer. Machinist,* Vol. 86, Nov. 26, 1942, pages 1383-1386.

Cemented Carbide Tools in Germany

Condensed from "Automobile Engineer"

A recent German monograph on "Hard Metal Tools" is reviewed in which their special properties are discussed and the means to allow full advantage to be taken of cemented carbide tools described.

The outstanding properties of cemented carbides, or sintered hard metals, are hardness between that of corund and diamond, and great resistance to abrasion; owing, however, to their brittleness and low tensile strength it is not practicable to make tools entirely of sintered hard metals, besides the difficulty of sintering large pieces and excessive coat.

Only a relatively small tip is therefore used on a substantial steel shank. To get the most out of the tip the following practice for brazing a tip to the shank of a lathe tool has been developed:

(a) *Preparation of the shank and tip.* 1. The jointing surface of the tip is ground smooth and true.

2. The jointing surface of the shank is carefully machined and the tip fitted to it.

3. Both jointing surfaces are carefully cleaned of grease; *e.g.* by carbon tetrachloride.

4. The shank is preheated in the soldering furnace to 800 deg. C. (1472 deg. F.) and to avoid scaling, some flux, such as borax, is applied to the joint surface from the spoon-shaped end of a bar of non-scaling material. The tip is also preheated, preferably by placing it on the shank.

5. After the preheating, the jointing surface of the tip is brushed clean of scale with a wire brush. It is then

placed in the milled recess on the shank and the borax and solder applied. The solder may be either sheet, wire or granulated.

(b) *The brazing process.* It should be noted that a very thin film of brazing metal is sufficient to keep the tip in position. A thick layer of brazing metal actually endangers the tip, because it can be deformed by the cutting pressure and can cause bending, chattering, cracking or breaking of the tip.

1. After the melting temperature (1100 deg. C. (2012 deg. F.) for copper solder and 960 deg. C. (1760 deg. F.) for silver solder) the solder flows round the tip and a little flux (borax) and solder are added to the joint.

2. When the solder has run completely under the tip, the tool is taken out of the furnace and the tip is pressed firmly with a pointed rod against the support until the solder freezes, so that the film becomes as thin as possible and the tip is securely fixed to the shank. The rod used for pressure must be pointed so that the tip is not cooled too quickly.

3. Further cooling must be controlled in such manner that there is slow equalization of the heat tension between tip and shank. One method is to plunge the tool into pulverized carbon electrodes.

Brazing Solders

The solders for brazing are: (a) pure copper (electrolytic copper); this has sufficient tensile strength to keep the tip in position and is ductile enough to equalize tensions created during the soldering process.

(b) Silver or similar solders with lower melting points than copper are frequently used in fixing tips to tools that have to withstand lower cutting pressures (machining of light metals).

(c) A special patented soldering foil consisting of a nickel steel sheet 0.5 to 0.75 mm. thick and copper plated on both sides. This solder is recommended to avoid cracks in the tip caused by the different expansion of the hard metal and the material of the shank under heat, and also for soldering tips to twist drills with shanks of high speed steel.

Charcoal, gas muffled or electric furnaces may be used for soldering, but the furnace should have a reducing atmosphere and the temperature kept at a level a little above the melting point of the solder. Oxidation of tip and joints is prevented by excess of gas or by blowing in coal gas. Clamping of tip to shank should be used only for light cuts.

The keenness of the cutting edge is of utmost importance. The clearance angle for cutting tools for open-hearths and alloy steels is 4 to 6 deg., for hard and chilled cast iron 2 to 4 deg.; angle of top rake 16 to 20 deg. for open-hearth steels of 23 to 48 tons, and 14 to 16 deg. for 54 ton steel, 12 to 16 deg. for Cr-Ni steels, 8 to 12 for Cr-V steel and tool steel, 0 to 8 deg. for austenitic 12 per cent Mn steel, 10 to 15 deg. for hardened high speed steel, 165 tons tensile, and for stainless steels 38 to 43 tons, 0 to 4 deg. for Si cast iron, 0 to 6 deg. for

cast iron 200-400 Brinell, 10 to 12 deg. up to 200 Brinell, and 0 for hard and chilled cast iron.

The side slope of top rake is 3 to 5 deg. throughout except for malleable iron and silicon cast iron where it should be 5 to 6. A similar table was worked out for copper alloys and light metals and insulating materials, the latter having in general greater angles for all three angles.

Speeds and feeds for milling operations are recommended as follows:

Materials	Feed, in. per min.	Cutting speed, ft. per min.
Mild steel, medium	3.15- 12	325-200
Cr-Ni steel	0.4 - 1.2	100- 80
Cast iron up to 200 Brinell hardness	12 - 24	325-200
Cast steel	8 - 16	200-130
Red brass	up to 27.5	1300-650
Aluminum	60 -120	820 and less
Siluminium	20 - 30	650-325
Insulating materials	40 - 80	500-165
Glass	0.4 - 0.8	165
Cast iron 200-400 Brinell	8 - 16	230-100

Elimination of Vibration

Vibration should be eliminated as far as possible in using cemented carbide tools; and the tool rigidly clamped and the clearances in the slides and bearings of the machine must be small. For turning operations the tools should be set at the center line of the work piece to insure correct minimum clearance angle.

The machine must never be stopped with the feed engaged (*e.g.* for taking a size). Apart from greater cutting and therefore productive capacity of cemented carbide tools, they have the additional advantages of better quality of machine surface, smaller cutting force and a lower stress on the cutting edge.

Cemented carbides are used successfully also in dies for wires, pipe and rod drawing, faces of measuring gages, work plates of centerless grinding machines.

—*Automobile Eng.*, Vol. 32, Mar. 1942, pages 91-94.

Sintered and Hot-Worked Iron Powders

Condensed from "Iron Age"

Different methods of molding powders to solid parts are: Cold pressing and sintering often followed by sizing operations; hot pressing into final shape by pressing and sintering; and metal working old cold pressed and sintered blanks.

However, none of these methods is completely satisfactory, therefore improved properties were obtained with sintered, forged and rolled iron powders.

Types of iron powder used were sponge iron containing 99 per cent Fe and of 100 mesh size. The other was an electrolytic iron, soft annealed and containing 99.8 per cent Fe. Two grades were used, one coarse, passing through 100 mesh, with 50 per cent through 325 mesh; and the other fine, all passing through 325 mesh. The specimens were processed in three different ways.

Some Physical Properties

Sintered sponge iron showed that its density is 75 per cent of normal for low pressed compacts but can be improved to

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by second pressing. These values are higher for electrolytic iron compacts, especially in the single processed material.

Coarse electrolytic compacts reach densities approximately 98 per cent after being twice pressed at 50 lbs. per sq. in., and twice sintered at 1200 deg. C. (2192 deg. F.) for 1 hr. Hardness values for singly pressed materials being very soft, and twice processed giving Brinell figures between 65 and 80. Materials after second pressing showed Brinell hardness above 100.

Tensile data for single processed material was 4000 to 5000 lbs. per sq. in. and double processing could better this only slightly. Only the strained repressed electrolytic powder showed substantially higher values. Sponge iron twice sintered showed a distinct superiority both in yield and ultimate strength. Tensile data of 38,000 lbs. per sq. in. for hydrogen reduced sponge iron approaches standard values for fused and annealed electrolytic iron. Average tensile values of 56,000 lbs. per sq. in. for sponge iron compares with 48,000 lbs. per sq. in. for fine electrolytic powder compact and 43,000 lbs. per sq. in. for the coarse grade of electrolytic iron.

Modulus of elasticity increases from about 40 per cent of normal in the case of low pressed compacts, to a maximum of about 75 per cent of normal for twice pressed material. Elongation and reduction are as low as one-fourth of normal for low pressed and improve slightly with higher pressures. They are again increased by a double pressing and sintering but, with one exception, are not better than one-half of standard values for wrought iron.

In the group representing specimens twice sintered, an improvement is noticeable when sintering temperature is raised from 1000 to 1150 deg. C. (1832 to 2102 deg. F.) Sintering at 1300 deg. C. (2372 deg. F.) causes no important changes in these values. A similar increase in temperature for specimens twice pressed at higher pressure does not show any appreciable influence on strength and ductility.

Effects of Working

Effects of subsequent working on the properties of sintered iron show that density increases to 97 per cent of normal for 25 per cent reduction and approaches asymptotically the normal values with higher degrees of forging. Yield point and tensile strength obtained by forging average 38,000 and 50,000 lbs. per sq. in. respectively and are comparable with carbon free wrought iron. Modulus of elasticity remains below normal, in no case exceeding 90 per cent of the standard value. Elongation and reduction in area are also improved by hot forging, but remain short of standard.

In rolled iron, the increase of density and hardness with the degree of reduction is less steep than for forged metal, and the maximum values do not exceed 43,000 lbs. per sq. in. Modulus of elasticity data match those of hot worked metal, but the highest elongation and reduction in area figures are slightly below the maxi-

mum values found in forged material.

In conclusion it may be said that variations in processing steps in making molded and sintered metals permit control of mechanical properties.

Sintered iron may develop interesting properties if sufficiently high molding pressures and sintering temperatures are used. If iron compacts are twice pressed and heated, and if raw material is of high purity, densities better than 98 per cent of normal, and hardness, yield point and tensile strength within the range of fused metal can be obtained.

The technique of forging, subsequent to cold pressing and sintering, has been worked out on an industrial scale by H. Tormyn of Chevrolet. In this operation SAE X 1112 steel turnings are pressed into ½ lb. compacts, sintered at 1025 deg. C. (1877 deg. F.) hot forged and coined cold after trimming. They are used for cast iron bearing lock sleeves.

—Claus G. Goetzel, *Iron Age*, Vol. 150, Oct. 1, 1942, pages 82-92.

Heat Treatment of Tool Steels

Condensed from "Iron Age"

This article is a review of recommendations of the General Electric Co. When heating for forging, normalizing or hardening, the part should be preheated, unless it is small and of uniform section, or enclosed in a box or pipe.

In forging or rolling, the steel is heated to a temperature within the recommended range. After forging, cool the steel out of contact with moisture or cold air. Steels with a tendency to air-harden should be cooled in a retarding medium such as dry ashes, lime, or mica dust. Always anneal after forging.

Tool steel is annealed to full anneal or process anneal. Full anneal is used mostly after forging or rolling. Purpose is to develop proper structure, not only for machining, but also to insure best response to subsequent hardening. The method is to heat above critical temperature and cool slowly.

Process annealing is used either to soften material which has previously been hardened, or to remove internal stresses and other undesirable effects. This is done by packing steel in a suitable container. Heat to about 1300 deg. F. and hold for the indicated time. Cool the container then remove the steel.

If softening is required, the steel is heated without protective enclosure. In hardening, always preheat unless tools are small and uniform, or pack-hardened. Slow, uniform heating and accurate temperature control are essential when tempering. Unless otherwise specified, hold 1 hr. at temperature and cool in still air.

In general, water should be used for quenching the water-hardening steels with forced circulation; brine for still-quenching the water hardening steels; oil as a milder, non-deforming quench; and air as the mildest quench. Water should be city or well water, not river water.

If controlled atmospheres are not used for heat treating, then ordinary carburizing compounds, pitch, coke, or cast iron ships will serve the purpose. Pitch coke is noncarburizing to most steels in the range of

1650 to 1950 deg. F. Below 1650 deg. F. it is strongly decarburizing and should not be used. Above 1950 deg. F. it will blister and destroy steel.

Carburizing compounds may be used in the range of 1100 to 1875 deg. F. Above critical temperatures they increase the carbon content. This is not generally detrimental. On drawing, forming and lamination dies, etc. may prove beneficial. However, it should not be used when maximum toughness is required. It should never be used for the high speed or hot work classes of steel.

When steel is packed for heat treatment, place the end of an asbestos covered thermocouple in a hole in the piece of steel nearest the center of the load. All tools should be inspected for hardness before leaving the heat-treating department. If cracks are suspected, the magnetic crack detector should be used.

—J. E. Erb, ***Iron Age***, Vol. 150, Oct. 8, 1942, pages 47-50.

Processing Beryllium-Copper

Condensed from "Sheet Metal Industries"

Beryllium-copper has the outstanding characteristics of being capable of heat treatment. It can be formed in the soft condition, then heat treated to 350 to 400 Brinell. This property along with its good electrical conductivity, corrosion and wear resistance, has caused it to be used to a greatly increased extent for parts of electrical equipment and instruments.

Originally beryllium-copper had about 2.5 per cent Be; however, in recent years, the beryllium has been decreased to about 2 per cent with the addition of about 0.5 per cent Co which gives somewhat improved and more uniform properties. The use of this alloy for springs eliminates the possibility of season cracking, undesirable creep effects, and gives a high elastic limit (50 tons per sq. in. as compared with 30 to 35 for hard drawn phosphor bronze which cannot be formed) as well as being suitable for use up to about 200 deg. C. (392 deg. F.) without loss of strength.

Effects of Pressing and Rolling

No difficulty is experienced in handling beryllium-copper in the press shop, although it work hardens rather more rapidly than the usual brasses and bronzes. A reduction in diameter of 30 per cent for the simple cupping operations should not be exceeded as against some 40 per cent in the case of brass. Either double action or single action presses may be employed, but a double action press and blankholder is preferred unless the blank thickness is sufficiently great to prevent wrinkling.

Punch and die radii should be the same as for brasses and bronzes. A good drawing lubricant (preferably with high film strength and a solid lubricant) is advisable. The most generally employed process is a drawing operation in steel tools, but a rubber bolster may be used in place of the lower steel tube. In designing bending tools, an appreciably greater spring back must be allowed than for corresponding tempers of phosphor bronze.

Beryllium-copper is not as susceptible to directionality as are heavily cold rolled alloys such as phosphor bronze. The temper

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There is hardly a theater of war today where N-A-X 9100 Series is not at the beck and call of our armed forces. If you looked for it, you wouldn't find it. It's there, though, in tanks, bombs, trucks, anti-aircraft and other types of guns and armament. And there it will stay until Victory is won.

N-A-X 9100 Series is an outstanding achievement of Great Lakes engineers and metallurgists. (*It is basically an alloy steel, with all strategic elements carefully balanced and held to an absolute minimum.*) It is being supplied in two general grades, with and without molybdenum, all other components of the analysis being held constant.

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used is a function of the amount of forming. No attempt should be made to carry out bending or setting operations after final heat treatment. In changing from spring steel, a gage 16 per cent thicker should be used to compensate for the difference in modulus of elasticity; no change is necessary in changing from phosphor bronze or nickel-silver.

Intermediate annealing, if necessary, is carried out by heating to 800 deg. C. (1475 deg. F.), soaking for 20 to 30 min. and quenching in water. If the parts do not attain this temperature or if the quenching is delayed, the properties obtained in the final hardening treatment will be adversely affected. A controlled atmosphere is not necessary if the parts can be pickled after annealing. Usual pickle contains 5 lbs. sodium dichromate, 2 pints concentrated sulphuric acid, and 5 gals. of water.

Heat Treatment

The heat treatment is a function of time and temperature. Best results are obtained:

From annealed condition, 2 hrs. at 310 to 320 deg. C. (590 to 610 deg. F.)

From quarter or half hard condition, 1½ hr. at 300 to 310 deg. C. (575 to 590 deg. F.)

From hard rolled condition, 1 hr. at 300 to 310 deg. C. (575 to 590 deg. F.)

[*Better results are being obtained in the U. S. A., using shorter times and higher temperatures than these.—F. P. P.*]

Cooling may be done by quenching or cooling in air. Finished articles should be adequately supported to avoid distortion. Atmospheric control is not necessary if the articles can be subsequently pickled, but the use of a hydrogen or nitrogen atmosphere is necessary with thin diaphragms or very small springs.

Beryllium-copper may be soft soldered without appreciable difficulty after final heat treatment. It may also be silver brazed before heat treatment. Any difficulty encountered will be due to the presence of a thin surface film of beryllium oxide. This film is generally removed with a zinc chloride flux if the parts can be washed after soldering to avoid corrosion. Electrical parts which cannot be washed after soldering must be joined with a resin flux. Resin cored solder may be used, in which case no additional flux need be applied, or the surface may be painted with a solution of resin in methylated spirits. Tests with low melting point silver solders (630 deg. C. melting point — 1166 deg. F.) showed that the final properties are not affected to any appreciable extent and that this method of joining is satisfactory. Reheating and quenching from 800 deg. C. (1475 deg. F.) is not necessary before hardening, although it is desirable to cool quickly in water after brazing.

Beryllium-copper can be spot welded. The tensile strength of the joint after heat treatment is considerably lower than that of the unwelded material (*e.g.* 307 Vickers as compared with 390) but higher than the cold rolled strip (216 Vickers). The ductility is low.

The usual metals may be successfully

electro-deposited if reasonable care is taken in preparing the surface. After polishing, the work is cleaned in the usual electrolytic cleaners of the phosphate type, then given a quick etch in the H_2SO_4 — dichromate pickle, rinsed and plated. If trouble is encountered, it may be overcome by giving a quick flash in an acid copper bath. However, many parts are being plated direct with silver.

—L. B. Hunt, *Sheet Metal Ind.*, Vol. 16, Nov. 1942, pages 1697-1705.

Formation of Austenite in Heat Treatment

A Composite

After a number of years of increasing interest in S curves and the formation of pearlite from austenite, attention has been turned to the opposite phenomenon — formation of austenite from pearlite. Since both processes are involved in heat treatment, it is to be expected that the study of the formation of austenite will also lead to practical results which can be applied by the heat treater.

Eutectoid Steels

Roberts and Mehl (American Society for Metals Preprint No. 22, 1942) discuss the mechanism of the formation of austenite and the measurement of the isothermal rate of formation.

Austenite forms by a process of nucleation and growth. Both the rate of nucleation and the rate of growth are structure-sensitive properties (in the formation of pearlite from austenite, the rate of nucleation is structure-sensitive, but the rate of growth is structure-insensitive). In eutectoid steels, the only factor establishing the initial austenite grain size is that of impingement of growing nodules.

The austenite formed in eutectoid steels is not homogeneous when pearlite disappears, for undissolved carbide remains, the solution rate of which depends on time and temperature. Even after the carbide is no longer visible in the microstructure, carbon concentration gradients exist for appreciable periods.

The rates of formation of austenite have been studied metallographically and analyzed in terms of the rate of nucleation and the rate of growth. Banding will result in a spreading of the isothermal reaction curve over a longer time period. The rate of formation increases continually with temperature above the Ae_1. Isotransformation diagrams are given. For example, for a 0.78 per cent C steel with an initial structure of fine pearlite and an Ae_1 of about 1330 deg. F.: At 1400 deg. F., pearlite is present for about 5 secs., without any appreciable austenite formation; after 10 secs., the structure is austenite with residual carbides; and not until after about 1000 secs. do the carbides disappear leaving austenite with carbide inhomogeneities. At 1450 deg. F., the austenite begins to form after 2 secs., the pearlite disappears after 8 secs., the carbides after about 100 secs., and the austenite is homogeneous after about 6000 secs.

As the pearlite spacing of the initial structure decreases, the rate of nucleation

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"Vitric-10" hardens entirely by internal chemical reaction, taking an initial set within 20 to 25 minutes and a final set within 24 to 36 hours. No artificial heating or drying is required. Unlike the average cement whose surface drying rate is more rapid than the interior rate, "Vitric-10" hardens uniformly throughout the joints and behind the brick, with a minimum of shrinkage.

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and the rate of growth of austenite increase, leading to an overall increase in the rate of reaction roughly proportional to the increase in the carbide-ferrite interfacial area.

For the same analysis, the same austenitizing temperature, and the same initial structure, the rate of growth of austenite was less for an aluminum killed steel than for a non-killed steel. The rates of nucleation were about the same. For the same rate of growth, the rate of nucleation was higher for the aluminum killed steel.

It was found that the initial austenite grain size could be calculated from the ratio of the rate of nucleation to the rate of growth and that these figures agree closely with the fracture grain size. The fine initial austenite grain size of the aluminum killed steel is accounted for by the high ratio of the rate of nucleation to the rate of growth. Fine pearlite produces a slightly finer grain size than coarse pearlite.

There are three general types of relationship between initial austenite grain size and the rate of heating. If the rate of nucleation increases faster than the rate of growth with increase in reaction temperature, the grain size will decrease with increasing heating rate. In the opposite case, the grain size will increase with increasing heating rate. If both rates increase at the same rate, no effect of heating rate on grain size will be noted.

Pure Iron-Carbon Alloys

Digges and Rosenberg (American Society for Metals Preprint No. 20, 1942) made a metallographic study of the formation of austenite in an iron-carbon alloy with 0.5 per cent C. The austenite is nucleated at the interfaces of ferrite and carbide. When the initial structure is fine pearlite, the nucleation takes place preferentially at the boundaries of the pearlite and pro-eutectoid ferrite and at the boundaries of the pearlite colonies, but sometimes within the pearlite colonies.

The austenite grows in finger-like forms, usually in the direction of the lamellae of the initial pearlite, but growth also extended across the lamellae. With increasing temperature, the per cent austenite increases and the carbon content of the austenite decreases as the ferrite is absorbed. At the Ac_3 point, only austenite is retained. When the alloy was spheroidized, a carbide network was formed.

With this initial spheroidized structure, the austenite is nucleated usually at the network, but to some extent within the network. During the formation of austenite from either initial structures, the carbon diffuses through the ferrite to the growing austenite grains; also, during the absorption of the ferrite, the carbon diffuses through the austenite.

At first, the austenite is always fine grained, regardless of the initial structure or the rate of heating through the Ac_1. However, if the rate of heating through the Ac_1-Ac_3 range was relatively slow, the grain growth was not inhibited and the resulting austenite was very coarse grained.

The authors conclude that the predominant factor in establishing the final aus-

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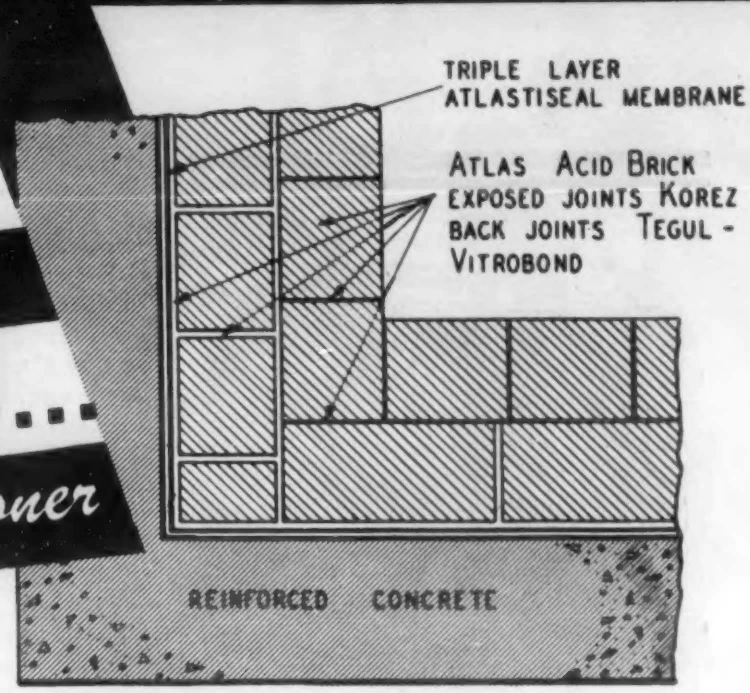

ATLAS DUAL Construction is used for PICKLING TANKS handling sulphuric, hydrochloric, hydrofluoric, nitric, phosphoric—or mixtures of these acids—to pickle STEEL, STAINLESS STEEL, ALUMINUM, etc.

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Tank 165' long, handling solutions ranging from 0 to 25% sulphuric acid at 230° F. This tank is subjected to quick temperature changes. The problem of how to build such a unit was solved by ATLAS DUAL CONSTRUCTION with ATLAS Interlocking Expansion Joints. ▶

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tenite grain size of this alloy was the rate of growth and not the rate of nucleation.

Initial Structure and Heating Rate

Digges and Rosenberg (American Society for Metals Preprint No. 21, 1942) also investigated the influence of initial structure and rate of heating on the austenite grain size at 1475 and 1600 deg. F. of 0.5 per cent C commerical steels and iron-carbon alloy. One of the steels had sufficient aluminum addition for a controlled grain size; the other did not. The initial structures included coarse pearlite, medium pearlite, fine pearlite, bainite, and spheroidized cementite.

In the case of the alloy, the initial structure had no appreciable effect on grain size. Relatively fine grains were produced by rapid heating and coarse grains by slow heating. Not only was the rate of heating much more important than the initial structure, but it also even overshadowed the effect of austenitizing temperature.

At 1475 deg. F., fine pearlite or bainite gave a slightly coarse grain size in the uncontrolled steel than did the other structures. The rate of heating was at the most of minor importance, and had no effect when the initial structure was either coarse pearlite or spheroidized cementite. At 1600 deg. F. there was no marked effect of either structure or rate of heating.

With the controlled steel, the effects observed depended chiefly on the rate of heating with almost no effect of initial structure. The rate of heating also outweighs the effect of austenitizing temperature. Contrary to the results with the alloy, the finest grains were obtained with slow rates of heating.

Therefore, both initial structure and rate of heating affect the austenite grain size, but the rate of heating is the most important. The rate of heating is most pronounced in the case of the alloy; it is more marked in the case of the controlled than the uncontrolled steel.

Machining Sprayed Metals

Condensed from "American Machinist"

In machining sprayed metals, the followings factors must be taken into consideration: (1) The coating is granular, not homogeneous; (2) the analysis, temper, diameter and physical properties of the wire to be sprayed; (3) the texture and density of the coating.

The finer the atomization, the better the machined or ground surface. A low transverse speed during spraying will lead to laminated coatings, which tend to separate into layers on machining. A high spraying temperature will cause warping or cracking of the sprayed metal; spraying should then be stopped until the part is cool enough to touch.

To avoid oxide in the coating, the gun should have a neutral flame setting. Also the gun should be 5 to 8 in. from the surface to be sprayed and the spray should hit the surface at 90 deg., if possible, but never under 45 deg.

There is a tendency to tear on machining. It is suggested that the first cut machine to within 0.010 to 0.015 in. of

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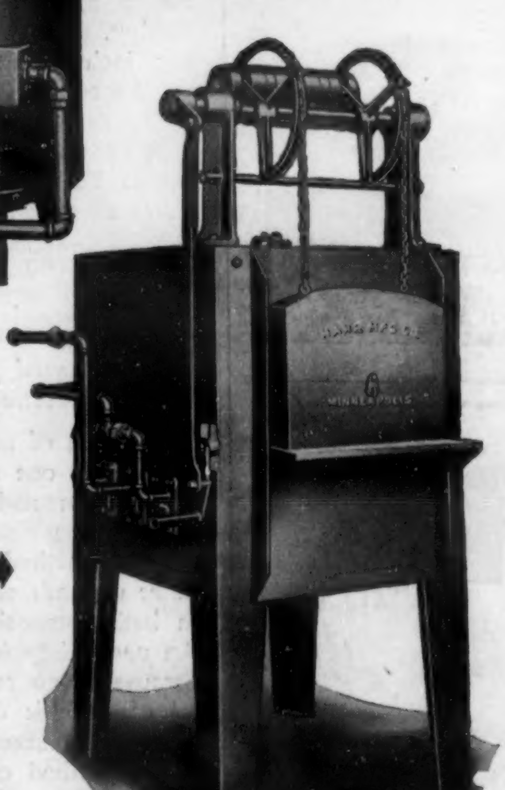
MAHR Standard Pot Furnace with hood for cyanide, etc. Made in many sizes and types, including rectangular type for molten bath. These furnaces are specially designed for longer pot life—often as much as 25% to 50%!



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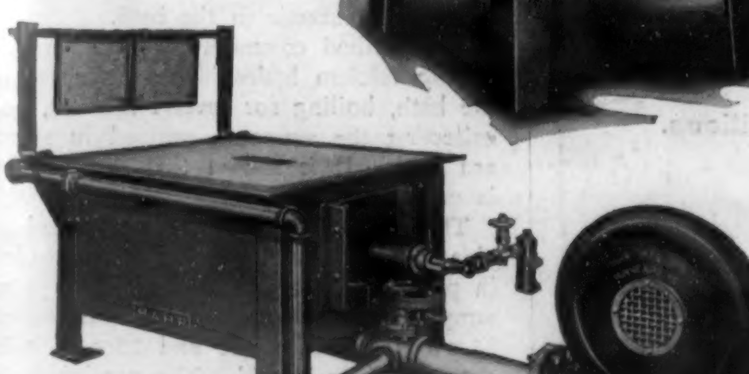

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the finished diameter; then the balance should be removed in a single cut. Sprayed metals have considerable abrasive action on the tool nose; it is therefore easiest to maintain accurate diameter (as well as get a better finish) with sintered carbides.

The wear can be minimized by polishing the tool nose with a hand stone and by leaving a slight flat on the nose. The sintered carbide tool requires no more support than usual, since no heavy cuts are taken and the transverse load is light. The side cutting edge angle is of no importance.

Grinding is being used more and more. There is no trouble in wet grinding, but all sprayed metals tend to load the grinding wheel. A relatively coarse grain is required with a low bond strength. If the flattest possible surfaces are required, a shaper or planer should be used, not a miller.

Polishing is done if a lustrous finish is required. Tin, Babbitt, zinc, and aluminum are easy to polish; red and yellow bronze are harder, while sprayed steel is hardest. Difficulties encountered in polishing include cutting through the coating on the edge and corners, and blisters due to hot spots or pressure by a loaded wheel.

Wire brushing is satisfactory for many metals but does not have any particular effect on steel and steel alloys.

—W. C. Reid, *Amer. Machinist*, Vol. 86, Oct. 1, 1942, pages 1084-1087.

Ammonia in Brass Plating

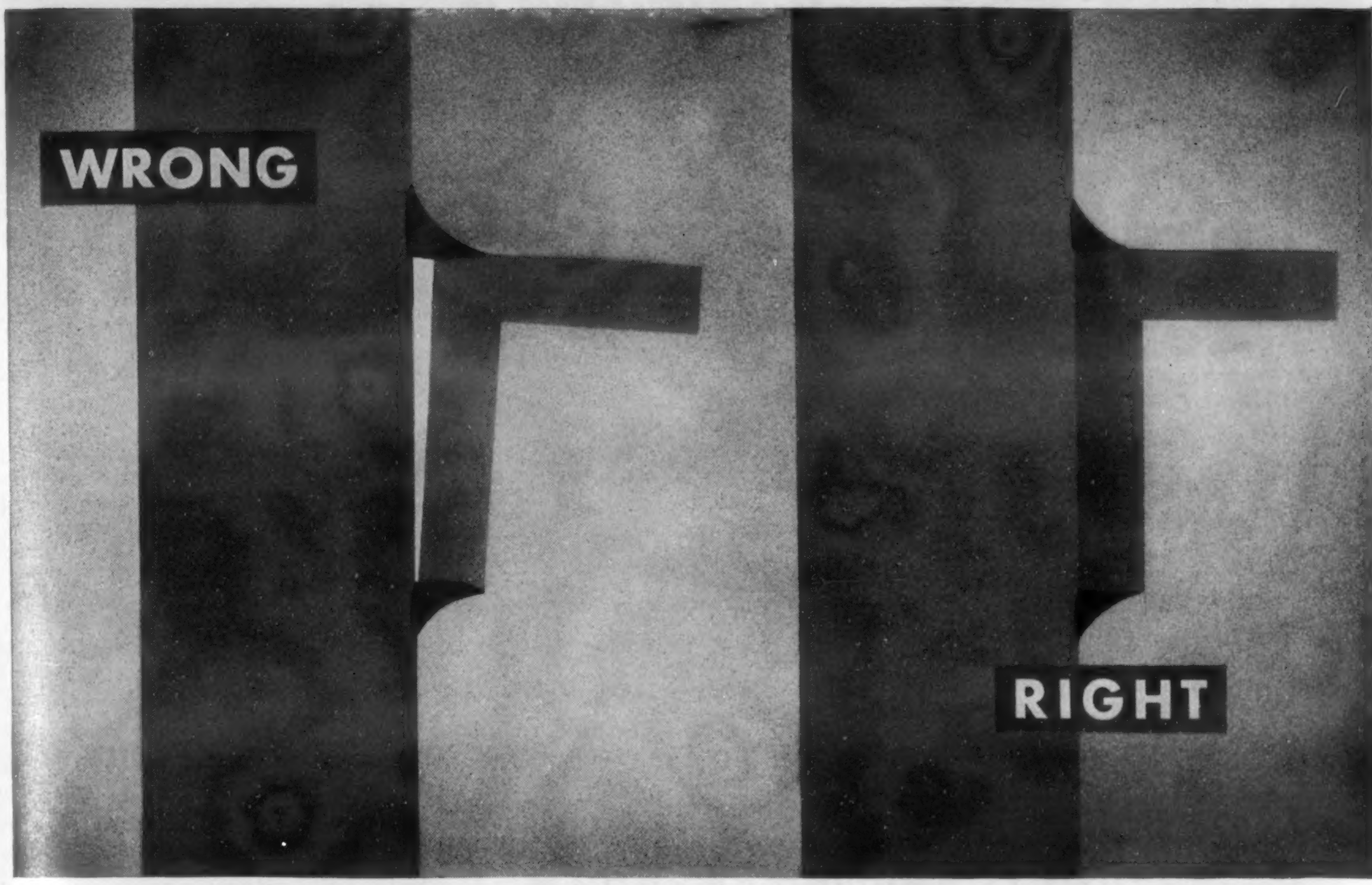
Condensed from a Paper for the Electrochemical Society

Addition of ammonia to a brass plating solution is one method of controlling the composition and color of the deposited brass. The author reviews the literature on this method of control and also on other methods of control such as variation in bath composition and current density. An uncertainty in the earlier results exists because in no case is a satisfactory method of analysis described or used for determining ammonia in the bath.

The method commonly used consists in adding calcium hydroxide to a sample of the bath, boiling for several minutes, and collecting the ammonia evolved in standard acid. It is shown that this method is quite unreliable.

The following procedure was found to give consistent results and is recommended in place of the above method: To a 10cc sample of the brass solution is added 25cc of distilled water and 25cc of cold 1 to 4 sulphuric acid. The precipitate is filtered and washed with 50cc of water. The filtrate is evaporated to fumes, cooled, and diluted to 250cc. A few drops of phenolphthalein is added, then solid calcium hydroxide until the slurry turns pink. It is then distilled ½ hr. in a kjeldahl apparatus. The evolved ammonia is collected in excess standard acid, which is titrated with standard alkali.

It was found that there is an almost straight line relation between the ammonia concentration and the copper content of the brass deposit. The copper content of the deposit increases as the ammonia concentration is increased. The copper



Showing waste of weld metal due to inaccurate fit-up. Errors of this kind can result in electrode consumption double or more of what is required.

HOW IMPROPER FIT-UP WASTES ELECTRODES

OPERATIONS prior to welding often affect the ultimate cmount of weld metal required. Attempts of the welder to correct improper fit-up, for example, will result in waste of electrodes, as well as labor and power. ¶ To help conserve the vital supply of welding electrodes: (1) Every joint must be designed so that the minimum of weld metal can be used, without sacrificing strength. Irregular contours should be avoided wherever possible, and proper allowance for distortion caused by welding should be made. (2) Layout work, cutting and shaping must be done accurately, and close tolerances maintained. (3) Fitting-up must be accurate, jigs and fixtures being used wherever possible.

This is one of a series of advertisements on the important subject of electrode conservation. If you wish reprints of the series as they are issued, send us your name and address.

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content of the brass increases with decrease in current density and with increase in temperature. Quantitative data on these variables are given.

Analysis of freshly made baths shows that some ammonia forms when a new bath is prepared. It was also found that additional ammonia is formed during operation of the bath. The ammonia thus generated reaches a maximum concentration which depends on the operating temperature of the bath.

—J. H. Monaweck, *Trans. Electrochem. Soc.*, Preprint 82-28, Oct. 1942, pages 331-338.

Modern Brazing Practice

Condensed from "Electrical Review"

Brazing has been used considerably in the electrical industry for joints in squirrel-cage rotors, switchboard bus-bars, and connections and joints in wires during manufacture. It is not as extensively used as soft soldering because it requires greater heat and skill, and involves risk of damage to insulation. Soft soldering gives all the strength and other characteristics necessary for most joints.

Improvements in brazing materials and methods have resulted in lower working temperatures, increased strength of joints, and easier working. With most of the world tin supply in enemy hands, brazing, where possible, is officially suggested instead of soft soldering.

Brazing materials include (a) alloys consisting of copper-zinc alloys; (b) alloys of silver, copper, and zinc; (c) alloys of copper, zinc and silver, with other constituents such as phosphorus; and (d) copper.

The (a) alloys are the cheapest, but require the highest working temperature. The joints are not as strong as those made with the other materials.

The (b) alloys are known as "silver solders." They give strong joints, have lower melting-points and are easier to work than (a). They have almost entirely superseded the latter in the electrical industry.

The (c) materials are much cheaper than (b), and have characteristics equal to, or better than the latter. The phosphorus-silver solders are applicable only to copper and brasses, and are particularly interesting for electrical work, especially as copper can be brazed without flux.

Copper is used as a brazing material only in furnace brazing steel parts in an inert atmosphere.

British Standard Specification 206-1941 lists three grades of silver solder. The properties of these and two other silver alloys are tabulated below. "Easy-Flo" solder corresponds to Grade C standard solder. Grade C is remarkably free flowing.

A flux is always necessary with standard silver solders. For A and B, fused borax, preferably mixed with alcohol to form a paste, is generally used. A special flux containing borax and potassium or sodium fluoride is used for C. Fluoride flux can be used instead of borax with A and B. Any flux residue must be removed to avoid corrosion.

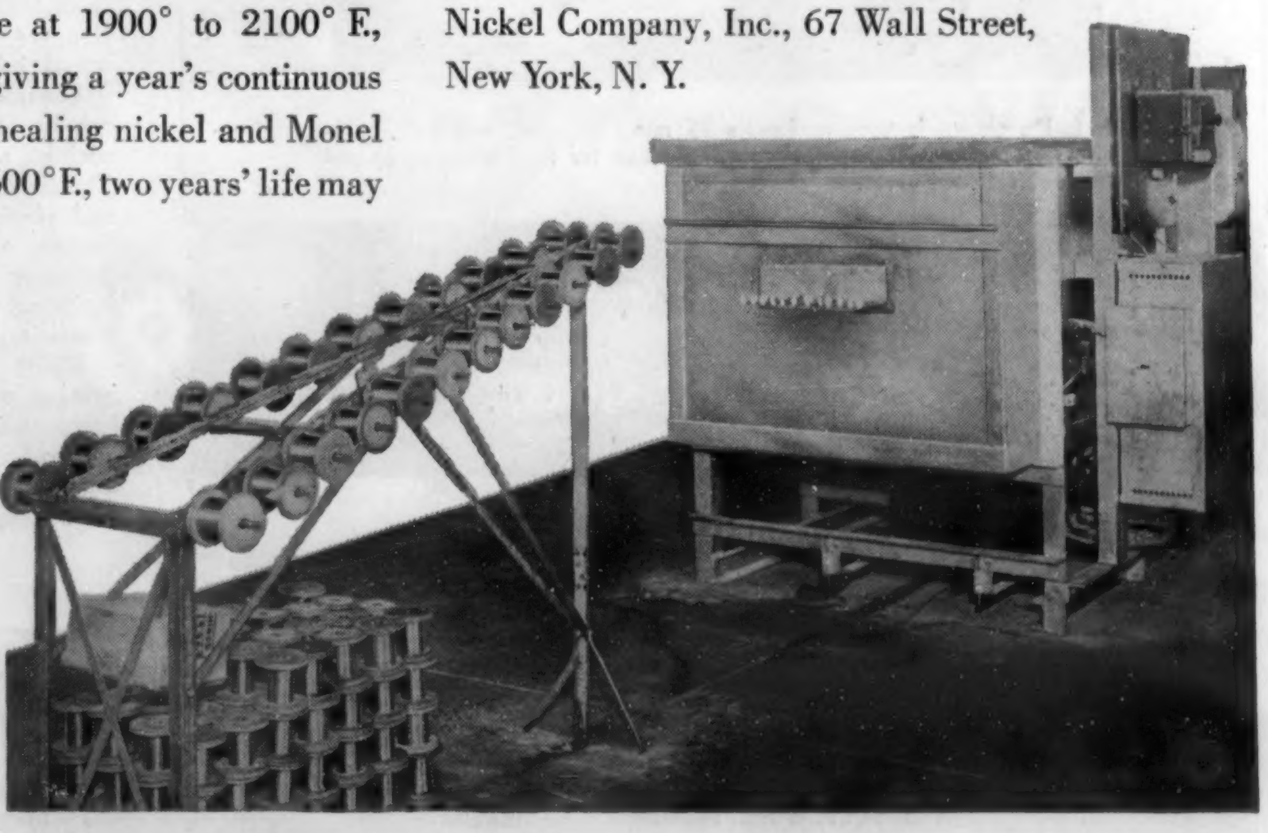
While fluoride flux is more corrosive than borax, it can be removed more easily

At temperatures as high as 2100° F. encountered in bright annealing furnaces Inconel is giving over a year's service

In the bright annealing of wire, single strands move continuously through heated tubes in strand annealing furnaces. An atmosphere of hydrogen is maintained inside the tubes to prevent oxidation of the heated wire surface.

In many furnaces, such as that shown here, cold-drawn seamless Inconel tubing which is annealed at a high temperature for improved creep strength, is proving to be one of the best materials available for these tubes. For example: In the bright annealing of stainless steel wire at 1900° to 2100° F., Inconel tubes are giving a year's continuous service; and in annealing nickel and Monel wire at 1500° to 1600° F., two years' life may be expected, providing, however, that wire is kept free from wire drawing compounds (oil, grease, soap and metallic lubricants) which tend to shorten the life of the tubes.

The foregoing details of this successful use of Inconel, a wrought, nickel chrome, heat-resistant alloy, have been published in the belief that they will be of interest and value to engineers and designers working on similar products, as well as to those who are planning for the future. The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.



Strand annealing furnace equipped with Inconel tubes. Is used in the annealing of Monel, stainless steel or other alloy wire. A hydrogen atmosphere is maintained inside the tubes and temperatures go as high as 2100° F.

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MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

by warm water, so that on the whole it is preferable even where A and B solders are used. When using "Sil-Fos" or "Silbralloy" with brasses or bronzes, a borax or fluoride flux is used.

Silver solders having conductivities nearly 80 per cent of that of high-conductivity copper are available, but the conductivity of the usual silver solders is 20-40 per cent.

Silver solders are available in various forms. Practice, particularly where semi-skilled labor is employed, is to supply the material in the form of rings, washers, or plates containing the correct amount to make the joint. This insures economical use.

	British Standard Grades A	B	C	"Sil-Fos"	"Silbralloy"
Composition %					
Silver	61	43	50	15	2
Copper	29	37	15	80	91.5
Zinc	10	20	16	—	—
Cadmium	—	—	19	—	—
Phosphorus	—	—	—	5	6.5
Melting-point °C. (Liquidus)	735	775	630	705	694
Brinell hardness	103	96	131	187	95
% Elongation	16	12	35	10	5
Ultimate strength (tons per sq. in.)	25	22	30	46	35

In designing joints, the main points to consider are that the silver solders can not be used as filling, and that space should be left for the solder to enter. It will flow by capillarity through a space of 0.001-0.003 in. but not less, so that riveting prior to soldering should be avoided. If space is greater than 0.003 in., the joint will have less strength. Adequate venting should be provided so that excess flux, gases, etc., can be driven out as the solder enters. The surfaces to be joined must be clean and free from oxide.

Heating Mediums

For brazing cage rotors, switch parts, bus-bars, and general work, the most usual heating medium is the gas torch. Coal-gas and air is the simplest, cheapest, and most convenient means of heating. Hotter flames are often used, the most popular being oxyacetylene. Because of the greater temperatures, some care is necessary when using the oxyacetylene flame to prevent burning, particularly of thin sections. Therefore, the writer prefers the slightly slower coal-gas and air flame.

Electric heating in which the parts to be brazed are clamped between carbon electrodes is being increasingly used. This method, where applicable, is much more suitable for semi-skilled workers than a torch. It is economical in fuel consumption, as the current is on only for the actual joining period.

Considerable economy in time and gas can be effected by preheating large parts, such as rotors, in a muffle before brazing. This insures thorough heating of the parts and obviates risk of failure by localized heating, which may occur with the torch. Economy in heat can also be achieved by inclosing the work as far as possible with insulating bricks.

While silver solders are dearer than brazing solders, the smaller amount of heat required, quicker working, lower labor cost, and very small amount of solder used per joint outweigh the disadvantage of the high price.

—*Electrical Review*, Vol. 131, Oct. 23, 1942, pages 513-516.

Copper "Stop-Offs" in Carburizing

Condensed from "Proceedings," American Electroplaters' Society

The results of early work on a variety of methods and materials tried as "stop-offs" to prevent carburizing of steel are reviewed and references given. Among the methods and materials that have been tried are:

(1) Immersion deposits of copper from sulphate and chloride baths; (2) shrunk-on steel sleeves; (3) electrodeposited copper; (4) electrodeposited nickel; (5) electrodeposited tin; (6) sprayed metal coatings (Schoop process); (7) leaving critical surfaces oversize and sub-

sequently grinding off; (8) packing with surfaces not to be hardened clamped into intimate contact; (9) clay, loam, and asbestos wrappings; (10) high temperature resistant paints and enamels; (11) putty; (12) mixtures of sodium silicate with clay, calcium hydrate, sand, etc.

Most investigators have obtained unreliable results with immersion copper deposits. However, such deposits are being used to a limited extent today, apparently with some degree of success in certain applications. Recommended thicknesses of plated copper range from 0.0004 to 0.002 in. Sprayed copper coatings have met with little success because of the high cost and ineffectiveness due to porosity.

The most satisfactory of the non-metallic coatings is a mixture of sodium silicate and asbestos. The effectiveness of nickel is the subject of controversy. Tin is effective upon surfaces on which it can be kept in place, but this is almost impossible except on specially shaped surfaces because of its low melting point.

High temperature resistant paints and enamels are found to contain too many voids after heating to carburizing temperature, probably due to the combustion of organic matter.

In the present work, the stop-off effectiveness of copper deposits on steel was studied to determine the relative effectiveness of deposits from different types of baths. Types of baths used were regular acid and cyanide copper, bright acid copper, bright cyanide copper, regular cyanide copper with both lead and cadmium added as brighteners, and rochelle cyanide copper. In addition, black oxide coatings, phosphate coatings, and cuprous oxide coatings were tried.

Out of 126 test pieces, plated with from 0.0001 to 0.001 in. of copper, only 8 showed penetration by carbon monoxide, and on each of these 8 the copper thickness was less than 0.0003 in.

It is concluded that the ability of a copper deposit to withstand penetration is not a function of its thickness, provided it is thick enough to be pore-free. Thicker deposits seem to be required from acid copper baths than from cyanide baths, and bright deposits have little advantage. Phosphate and black oxide coatings are valueless. Cuprous oxide seems to show some promise as a stop-off coating.

—M. M. Thompson, *Proceedings*, Am. Electroplaters' Soc., 1942, pages 28-32.

Aircraft Production Fixtures of Wood and Low-Melting Alloy

Condensed from "Western Machinery & Steel World"

Low-melting alloy Cerrobend [50 Bi, 27 Pb, 13 Sn, 10 Cd] is used most extensively in the production of all types of fixtures. The author claims all problems involving shrinkage, expansion, machining, drilling, tapping and aging, such as exist in certain plastics, are eliminated.

For example, a master mahogany three-dimensional model of an airplane engine forward cowl is prepared from the master steel templets. The model is fabricated so that it can be taken apart in sections at the joint lines of the different panels involved in the complete engine nacelle assembly.

From this model a complete set of female inside of metal checking fixtures is made by the use of mahogany fabricated Castaloy fixtures, having surfaces which are cast directly and accurately from the master model by using Cerrobend metal. The zinc punches for forming the outer skin parts are checked for correct shape by use of one of the female Castaloy fixtures.

Production assembly and drill Castaloy fixtures may also be made from the master model of the cowl. This fixture is fabricated of mahogany and steel, roughly to the contour of the cowl model, then placed over the cowl model, leaving a small space, approximately ¼ in., into which the Cerrobend is cast, resulting in a female fixture having the outside of the metal shape on its surface by simply adding metal thickness strips on the surface of the master model before pouring the Cerrobend.

The first step in obtaining the correct shape on dies is again the making of a master mahogany model. Directly from the master, a plaster pattern is cast which is used to cast a female die in the foundry of iron, steel, or zinc alloy. To allow for shrinkage and finish of the casting, plaster or strips of cardboard, wax, or paper are placed on the plaster pattern at points involving ordinary shrinkage and

finish problems before casting in the foundry.

After the die is cast, the casting is spotted to the master model and filed, ground, chipped or kellered until the model fits the surface of the die all over. The die is then used to make a stamping which is checked to a female Castaloy checking fixture made from the master model in advance of the manufacture of the stamping.

To have a means of duplicating dies accurately and to have a source of reference in case of die breakdowns, the female Kirksite die may be duplicated in reverse by a Castaloy fixture which is cast directly from the die itself. This practice is also very helpful with subcontracting, as a plaster mold for another die may be made quickly by filling in the Castaloy fixture with plaster.

Castaloy punches are used for forming the outer skin of an airplane rear fin. A hardwood block with a Cerrobend surface is used in a production press for stretching and forming the skin panels. It furnishes a good surface over which aluminum can be stretched without scratching.

All the Cerrobend or Cerromatrix used on the tools can be entirely reclaimed by remelting and using over and over again.

The effect of aging on shrinkage and expansion of similar fixtures of different materials showed the superiority of mahogany and Cerrobend:

	Size change after 103 days
Dural (cast)	—0.003
Solid mahogany	+0.003
Mahogany and Cerrobend	+0.001
Spruce	+0.003
Birch	+0.002

Proper use of such fixtures enables the saving of considerable time and effort and the work can be carried on more accurately than has heretofore been possible.

—H. G. Groehn, *Western Machinery & Steel World*, Vol. 33, Sept. 1942, pages 412-417; 424.

Heat Treatment vs. Corrosion of Duralumin

Condensed from "Sheet Metal Industries"

The susceptibility of duralumin to intergranular corrosion is purely the result of heat treatment and may be caused by: 1. Abnormally large drop in temperature between removal from furnace and quenching; 2. slow quenching speeds, as in hot water or oil; 3. reheating the solution treated duralumin over 120 deg. C. (248 deg. F.)

Unfortunately, each of these factors is helpful to production methods. Nos. 2 and 3 can be avoided, but No. 1 cannot be entirely eliminated as there is inevitably some delay in moving the metal from the furnace to the quench tank. The designer of a heat treatment plant must know the maximum permissible delay in quenching in order that suitable handling equipment may be installed.

Specimens of both 0.036 and 0.080-in. sheet duralumin (B. S. S. 5L.3) were soaked for ½ hr. in a salt bath at 485 to 500 deg. C., then quenched in a cold water quench tank after the following delays in quenching: 0, 5, 10, 15, 20, 30, 40, 50 and 60 sec., and age hardened at room temperature for 3 weeks. In this condition, the delay in quenching caused only a slight decrease in ultimate and proof stress.

Part of the samples were subjected to a 24-hr. accelerated corrosion test (at 10 deg. C. in solution with about 58 g. per liter NaCl and 27 cc. per liter concentrated HCl). Microscopic examination of the corrosion samples showed that even with sheet as thick as 0.080 in., a tendency to intergranular corrosion becomes apparent after a quenching delay of only 15 sec. Longer delays result in a progressively increased tendency to this defect.

Tensile tests on samples given this corrosion test showed: 1. The ultimate and proof stress were both progressively decreased by increasing delays in quenching; 2. the ultimate stress was most affected (for example even a 5-sec. delay caused a marked decrease in ultimate stress, while the proof stress was only negligibly decreased by a 5 or 10 sec. delay.)

Therefore, if the resistance to intergranular corrosion of sheet or strip duralumin between 0.037 and 0.080 in. thick is to be kept at a high value, the maximum delay between removal from the heating furnace and quenching in cold water should preferably be less than 10 sec.

Similarly treated samples of the 0.036-

in. sheet were exposed for 1 yr. to coastal atmosphere and then subjected to tensile tests to see if the accelerated corrosion test gave reliable data. The year's exposure to the sea atmosphere produced much less severe effects than the accelerated test. But atmospheric corrosion will produce serious reduction in ultimate and proof stress in all samples where the quenching delay was greater than 15 sec.

Microscopic examination confirmed that the reduction in tensile strength was the result of intergranular corrosion. Again, it is seen that the quenching delay should preferably not exceed 10 sec. However, if closely packed batches having a thickness in excess of 0.1 in. are heat treated, the rate of fall of temperature would be lower, and perhaps a slightly greater delay would be permissible.

A modified quenching treatment would be very helpful since the distortion resulting from the solution heat treatment is a constant source of trouble, especially to those concerned with cold pressing of duralumin sheet. Therefore, the effect of surface treatment on samples susceptible to intergranular corrosion was examined.

Sets of samples were made up as above. One set was treated with the Bengough anodic oxidation process; a second set was anodized and painted with one coat of chromate pigmented primer and one coat of aluminum pigmented nitro-cellulose lacquer; a third set was made of Alclad (D. T. D. 390) with no further treatment; and a fourth set consisted of Alclad, the surface of which had been intentionally marred by heavy scratches.

After exposure for one year to the same coastal atmosphere, the samples were subjected to tensile tests and microscopic examination. A comparison of the tensile tests on the first two sets with previous results showed the considerable value of anodizing and anodizing and painting, since there was only a slight decrease in ultimate and proof stress even for a 60-sec. delay in quenching.

However, microscopic examination of the anodized sample with a 60-sec. delay showed occasional small zones of intergranular corrosion, indicating that anodizing by itself cannot be relied on as a protection against intergranular corrosion. The two sets of Alclad samples showed very similar results, indicating little effect of the delay in quenching and little effect of the badly scratched aluminum coating.

Therefore, the results of accelerated corrosion tests on bare metal should not be used to judge the suitability for service of an alloy which is to be anodized, or anodized and painted in service. In the case of parts made from aluminum coated alloys, less drastic quenching methods might be used in the solution heat treatment, thereby aiding production by the reduction of distortion.

—J. C. Arrowsmith and G. Murray, *Sheet Metal Ind.*, Vol. 16, Dec. 1942, pages 1879-1884; 1910.

Powdered Coal for Forging Furnaces

Condensed from "Heat Treating and Forging"

This article supplements the study made and published in *Transactions* of the American Society of Mechanical Engineers, Vol. 65, Jan. 1943, pages 31-41. (Also in *Heat Treating and Forging*, Vol. 28, July 1942, pages 327-330, 336-338; Aug. 1942, pages 377-380, 400-401.)

The same furnace with burner, air and coal feeder has recently been used in a production trial in a drop-forging shop. The shop air system supplied air to the flame screen at the slot. An 8-in. steel stack, about 30 ft. high, was connected to the hood to remove the flue-gases from the shop. Elkhorn coal was dried and pulverized to 93 per cent through 200 mesh in the laboratory mill and transported to the plant in sacks. The tests covered 4 days.

In lighting up, gas pilot in each burner was ignited, and coal and secondary air were turned on immediately. Heating was rapid. After about 2 hrs., the gas was turned off. The amount of natural gas used by each burner was about 70 cu. ft. per hr.

A platinum-rhodium thermocouple was placed 2 in. from the back furnace wall near the hearth. During heating up, the couple heated faster than the rear wall but slower than the hearth.

The average time to reach forging temperature was 1½ hrs. when the furnace had been idle for 14 hrs. Adjacent oil furnaces used for 2 shifts required 1¼ hrs. to reach forging temperature.

The average fuel consumption for the 4 days of steady operation was 44.9 lbs. per hr. A much higher rate was required to secure rapid warming up, after which a somewhat slower rate sufficed. A maximum rate of rise of furnace temperature was obtained with 55 lbs. per hr.

Non-uniform heating of the charge was caused by the hot spot at the center of the hearth, which is characteristic of all of the furnaces, oil- or coal-fired, with opposed burners. Hearths of the oil-fired furnaces in the shop had been recently lengthened 30 per cent.

The coal-fired furnace is typical of the original smaller hearths. However, average production rate, pounds per hr. which includes the overall hammer and furnace rate, was only 6 per cent higher for the larger oil-fired furnaces than for the coal-fired furnace.

No ash was evident on the work, on the hearth, or in the shop. Some very thick slag was seen occasionally dropping from the front arch, but no fluid slag was observed on the hearth. There was no erosion of the refractory from flame impingement.

The hammerman, and others, thought that the scale on the steel was frequently thicker than that encountered in the oil-fired furnaces. No scale scraper was provided on this furnace while many of the oil-fired furnaces had means for scraping which the heaters used regularly.

The most severe scaling occurred on the first day of steady operation when the desired furnace atmosphere had not yet been realized. Reducing the air supply for the following days resulted in markedly less scaling.

Based on various observations and assumptions the relative costs per ton of steel heated appear to be \$1.75 for coal and \$6.00 for oil.

—R. B. Engdahl and F. E. Graves, *Heat Treating and Forging*, Vol. 28, Dec. 1942, pages 623-626.

"Roller-Coating" of Aluminum Sheet

Condensed from "Products Finishing"

Aluminum sheet stock up to a maximum thickness of 0.25 in. and a maximum width of 48 in. are painted with a zinc chromate paint on an automatic roller coating machine. The installation described is located in a California plant of the Douglas Aircraft Co.

An endless synthetic rubber belt carries the sheets successively through a hot caustic spray cleaner, a hot spray rinse, a hot air drier, the roller painting unit, and a second hot air drier. The sheets are manually turned and passed through a similar unit to paint the other side.

The zinc chromate coating protects the surface of the metal from scratching or other damage during fabrication operations. Many sheets go through forming operations such as beading, flanging, and certain blanking and hydro-press processes without injury to the coating and require no retouching after fabrication.

Advantages stated for the roller coating process are the following: (1) Routing of a part in and out of paint departments during fabrication is minimized; (2) the number of paint booths required is reduced; (3) evenness of the paint coat is controlled more directly than by hand spray; (4) considerable time and paint is saved; (5) when painted prior to fabrication all parts in an assembly are painted, including exterior portions; (6) necessity for spraying on the assembly line, with its attendant fire hazard, is eliminated; (7) absence of paint spray reduces the health hazard.

—Fred A. Herr, *Products Finishing*, Vol. 7, Nov. 1942, pages 46-48.

Helium Arc Welding

Condensed from "Welding Journal"

The new method of welding magnesium with tungsten arc in an atmosphere of helium is a development of the Northrop Aircraft Inc., Hawthorne, Calif., and is especially useful in welding magnesium for fabrication of aircraft structures. Defects in magnesium castings are easily repaired, and the weld metal is more dense and less susceptible to corrosion than the casting. The slow consumption of tungsten indicates a slight contamination of magnesium weld, which is not harmful to properties of magnesium weld.

There are also only minor heating ef-

fects in the adjacent base metal to the extent that Dowmetal J-IH alloy has 95 per cent of base metal strength in the butt weld. The Heliarc method has been successfully applied to welding of stainless steel, brass, Inconel, Monel and some carbon steels.

The helium valve in the torch is opened just prior to striking arc between tungsten and base metal. The specific heat of helium is high and, when helium is in motion, prevents heat accumulation around the weld, thus reducing distortion. The torch must be held close to the weld to obtain maximum benefit of gas shield in preventing oxidation; an arc length of 0.06 in. should be maintained.

Helium gas purchased from the government plant is sufficiently pure for direct use in a torch; a 200 cu. ft. tank will supply gas to a medium-sized torch for 35 hrs. of continuous welding. The presence of carbon dioxide, hydrogen, nitrogen and hydrocarbon in the helium may cause pronounced defects.

—T. E. Piper, *Welding Journal*, Vol. 21, Nov. 1942, pages 770-772.

Abrasive-Wheel Cutting

Condensed from "Transactions," Amer. Soc. of Mechanical Engineers

An analytical investigation was undertaken to predict how an abrasive wheel should be operated so that it will provide the best combination of production rate and total production before it wears out. The geometrical relationships involved in cutting round stock were determined, with the stock rigidly clamped and with the stock rotating in each direction relative to the wheel rotation.

Three factors influence wheel wear and material removed when cutting off stock with an abrasive wheel: (1) Unit contact force, (2) average carry of material or drag distance, and (3) porosity of wheel.

From the tests an equation was derived for the service factor $F = (\sigma/x_a)^2$, where σ = wheel porosity, measured in inches, is the theoretical maximum depth of metal which any part of the wheel can remove at 1 pass ($\sigma = (dA/dt)/R\Omega$. A cross sectional area of cut, t time, R radius of abrasive wheel, becomes smaller as wheel wears, Ω angular velocity of wheel in radius per second.)

With this equation, curves were derived showing the relative wheel life and wheel wear as influenced only by dragging of metal through the cut as a function of the work diameter, and taking both as 1 for stationary work. With a forward rotation of work, *i.e.*, work and wheel rotating in opposite directions at point of contact, the wheel life was 18 to 20 times as long as with stationary stock under proper conditions, while wheel wear was reduced to less than 0.1.

It is recommended to make test runs for certain definite conditions in order to establish the optimum of operating results.

—W. B. Heinz, *Trans. Am. Soc. Mech. Engrs.*, Vol. 65, Jan. 1943, pages 21-29.

Steel Grain Size and Weldability

Condensed from "Archiv für das Eisenhüttenwesen"

The effect of the austenite and ferrite-pearlite grain size of the base material on the formation of the heat-affected zone and on the course of hardness transversely to the welding seam was investigated in steel ST 52 in the rolled state and normalized.

No connection between alpha and gamma grain size could be established in the rolled condition; in the normalized condition, however, a connection was found inasmuch as the gamma-fine grain steels have also a finer alpha-grain.

The width of the affected zone decreases with increasing alpha-grain fineness; a dependence of the width of this zone on the gamma-grain size was not found. For very fine alpha-grain, transition zone and affected zone are equally wide as full demixing has taken place.

The hardness curve transversely to the welded seam as determined by the microhardness tester is more irregular in gamma-coarse grain steels than in gamma-fine grain steels. The zone of the intercrystalline ferrite in the transition structure shows a maximum width for an average alpha-grain size, and is wider for gamma-coarse grain than for gamma-fine grain steels.

—W. Eilender, H. Arend and R. Hackländer, *Arch. Eisenhüttenwesen*, Vol. 15, Mar. 1942, pages 419-422.

Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

CONTENTS

Ceramics as Substitutes

Condensed from "Modern Industry"

Ceramic products are now substituting for steel, alloys, rubber and plastics in important uses. The range includes: Ceramic centrifugal pump impellers taking 2,500 r.p.m.; tanks, pipe and pumps withstanding any corrosive liquid except hydrofluoric acid or hot caustic alkalies; gas burners for industrial furnaces, standing up to tests that break down brass and alloy steel; vessels withstanding the thermal shock from ice water to steam and back again; coal chutes and special inserts lining sand blast nozzles.

The general definition of ceramics includes those products, shaped of plastic clay and hardened by fire. Ceramic bodies of standard formulas are good heat insulators and excellent electrical insulators, unmatched for high frequency radio work. They are as chemically inert as any material known. Their melting points are about those of cast iron or iron alloys and their compressive strength compares with that of cast iron. Tensile strength is low but building the piece heavier sometimes overcomes this.

Single-unit pieces seldom go as large as 12 x 8 ft.; minimum sizes get down to porcelain contact insulators weighing about 1/900th of an ounce. Machining to tolerances of 0.010 in. is normal in some high-grade electrical insulators. In larger pieces tolerances normally range from 2 to 3 per cent.

These properties belong to objects shaped of plastic clay by casting, pressing, or extrusion and hardened by fire. Small complex shapes are die-pressed. Special cements are available for a variety of applications in building acid-proof tanks and linings. Lack of suitable methods of joining ceramic units has somewhat blocked building large complex assemblies.

Shaped ware, dried at low heats, may be machined, then fired in a kiln at high temperature. After firing, unglazed bodies may be further machined. The glaze (glass) which gives the hard, smooth non-corrosive surface, is usually applied in a liquid vehicle before final firing, when it becomes fused with the body of the ware.

Replacing Essential Materials

Ceramics are replacing essential materials in equipment for the manufacture of TNT, powder, chemicals, synthetic rubber, magnesium, gasoline and nylon. Liquor distilleries, converting to rubber production, will utilize all-ceramic rectification towers. Valves of stoneware are tested at 60 lbs. pressure. Armored with a cast iron shell they will take up to 200 lbs. Stoneware pumps will handle 1,000 gals. a minute; stoneware exhaust fans will draw 6,000 cu. ft. per min.

Improvement of ceramic bodies (final blend from which the product is formed) with new minerals makes it possible to cast intricate stoneware shapes and to grind and polish their dimensions to tolerances approaching those of some metals. The thermal conductivity of special bodies has sextupled in the last few years.

Believing ceramics to be fragile, workmen respect them and loss from breakage is small. All-china units of sanitary ware are replacing porcelain enamel which used tons of steel. A built-in tile bath tub uses only 7 lbs. of metal. A tile sink on a concrete base uses none.

Porcelain enameling, fusing a glass to metal, has been used to some extent to replace more critical materials in parts of such products as fire extinguishers, stirrup pumps, mess kits, canteens and table tops.

Porcelain enameled corrugated iron roofing and siding have replaced galvanized iron in the Canal Zone. In an air-craft hangar use of porcelain enamel saved 19 tons of zinc.

In abrasion resistance porcelain enamel is at the top. New ways are being found to bond thinner, harder coats of enamel more firmly to the metal base, and resistance to chipping from torsion, tension or impact has been greatly improved.

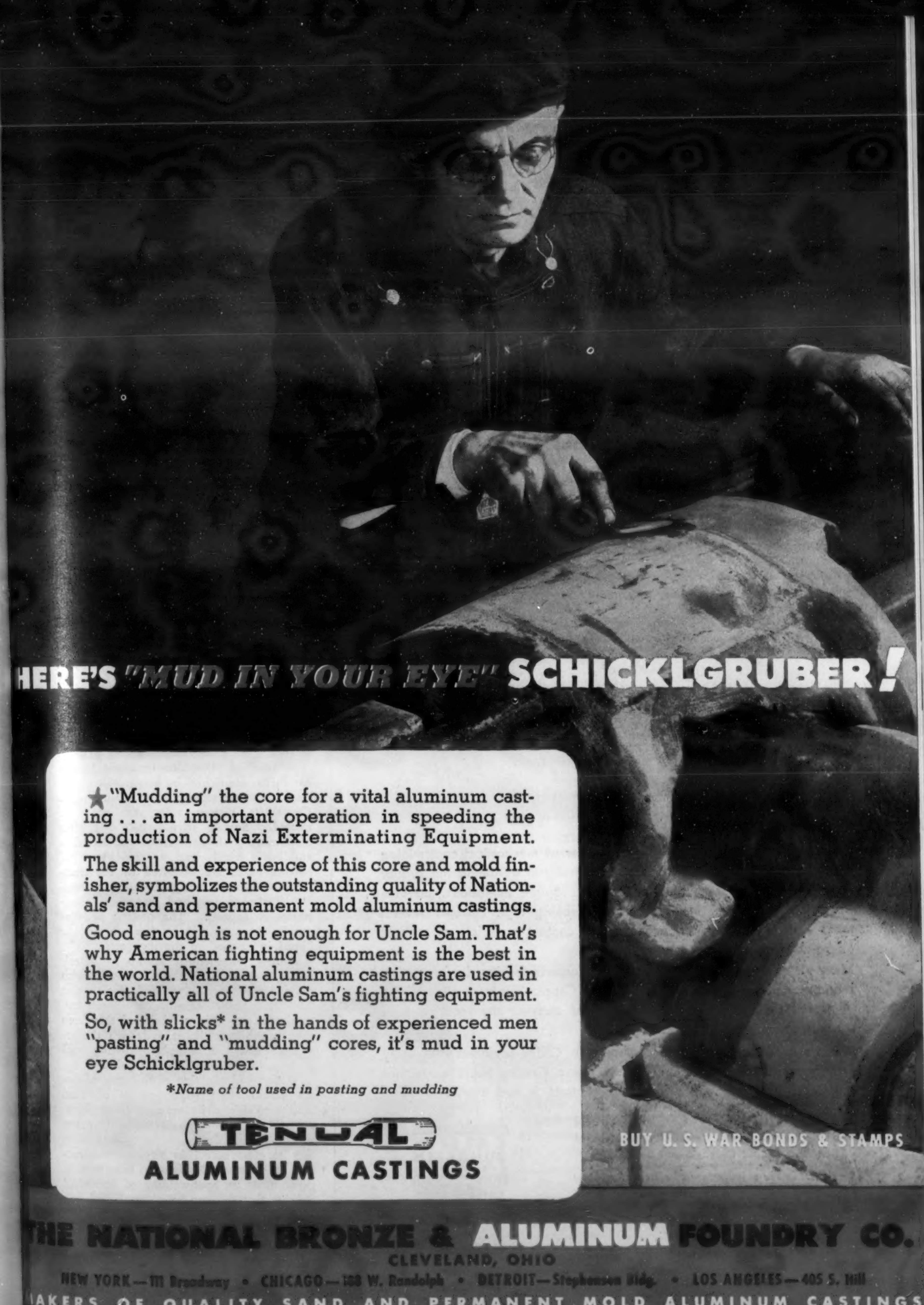
Electrical porcelain (all-ceramic) insulated wiring systems have come to the fore. Knob and tube insulators, light sockets, outlet boxes, and fuse boxes of solid porcelain are more widely used.

Steatite, a ceramic body of magnesium silicate, is used mainly in high-frequency radio systems which are on every ship, tank, and plane we produce. Before firing, steatite may be machined on ordinary metal-working saws, lathes and drills. The result is a superior non-hygroscopic electrical insulating porcelain of great mechanical strength that will stand up under a wide range of temperatures and climates and take terrific thermal and electrical shock.

Receptiveness to New Problems

There is a new spirit of receptiveness to new problems in the ceramics industries. Their engineers and manufacturers are anxious to tackle new tasks and anyone thinking that what he needs can be made of ceramics should work closely with them.

New applications now in the design



HERE'S "MUD IN YOUR EYE" SCHICKLGRUBER!
★ "Mudding" the core for a vital aluminum casting . . . an important operation in speeding the production of Nazi Exterminating Equipment.
The skill and experience of this core and mold finisher, symbolizes the outstanding quality of Nationals' sand and permanent mold aluminum castings.
Good enough is not enough for Uncle Sam. That's why American fighting equipment is the best in the world. National aluminum castings are used in practically all of Uncle Sam's fighting equipment.
So, with slicks* in the hands of experienced men "pasting" and "mudding" cores, it's mud in your eye Schicklgruber.
*Name of tool used in pasting and mudding
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and testing stage are: Closures for bottles, replacing plastics; all-porcelain coffee percolators; bases for machines, replacing cast iron; and gas stoves with glazed tile exteriors, refractory brick interiors and porcelain burners.

—*Modern Industry*, Vol. 4, Oct. 1942, pages 32-33, 66-68.

War Uses of Phosphate Coatings

Condensed from "Proceedings," American Electroplaters' Society

Phosphating consists of the treatment of iron, steel, zinc and their alloys with solutions which form a non-metallic phosphate coating on the metal. The physical characteristics of the phosphate coating, such as thickness and crystalline structure, can be controlled by the method of cleaning prior to treatment, the method of solution application, and by modifications in solution composition.

Two widely used phosphate treatments are Parkerizing and Bonderizing. The former produces a corrosion inhibiting and oil absorptive coating and the latter a phosphate coating adapted to increasing the adhesion and durability of subsequently applied paint finishes.

Small arms parts are Parkerized followed by treatment with a rust-inhibiting oil. The coating produces an increase in dimension of 0.0001 to 0.0003 in. per surface, but since the "build-up" is non-metallic it is not customary to change the dimensional tolerances given on manufacturing drawings.

The phosphate coating does not burn, chip, or peel at temperatures encountered during firing. The mat black finish reflects very little light, making detection of articles with this finish difficult.

To conserve zinc metal, an oiled, Parkerized finish is used on ammunition links and clips, as a substitute for zinc plating.

A modified phosphate treatment known as Parco Lubrizing is being extensively used to protect moving parts against wear. Cam-shafts, pistons, rings, etc. are thus treated. Surface irregularities left after machining, such as microscopic scratches and burrs which lead to rapid wear of moving parts, are dissolved by the treatment, and an oil absorptive coating consisting chiefly of iron and manganese phosphates is formed. The coating polishes rapidly to a smooth surface during the "break-in" period of moving parts.

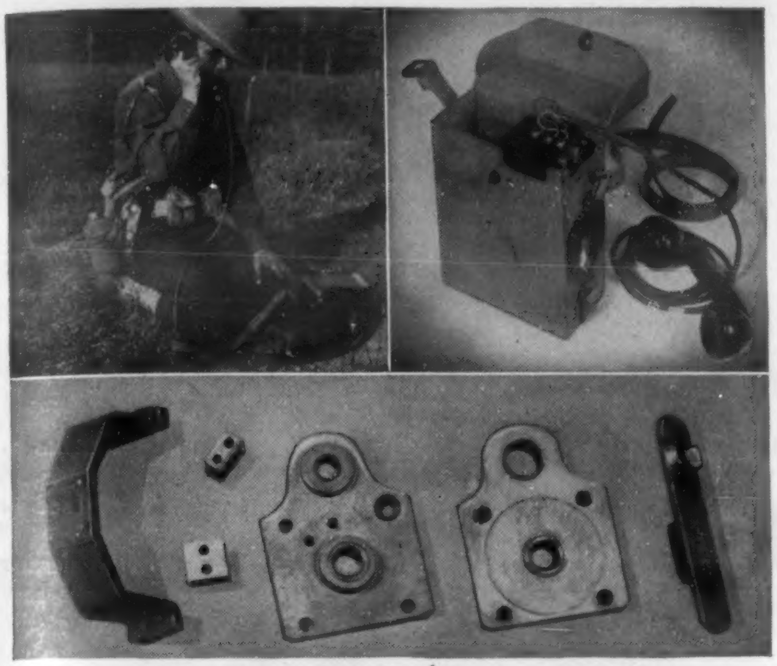
A new development known as "Steelbond" consists of sheet steel finished with a Bonderized electrodeposited zinc coating 0.00002 to 0.00005 in. thick. Sheets can be drawn and articles fabricated therefrom can be subsequently painted with the assurance that the phosphate coating will provide an excellent base for paint.

Widespread adoption of this type of finish would effect large savings of zinc. Ability to ship and store such sheets without rusting makes them suitable for many uses. Recent developments indicate that they may be useful in airplane construction to conserve aluminum. Results with experiments on spot-welding of Steelbond indicate that this can be accomplished successfully.

Tin for cans is being saved by the use of Bonderized black plate finished with sanitary lacquer or enamel. The phosphat-

FOR WAR TODAY—FOR YOUR PRODUCTS TOMORROW

PRE-WAR ENGINEERING SHOWED THE WAY



Die castings help to "get the message thru"

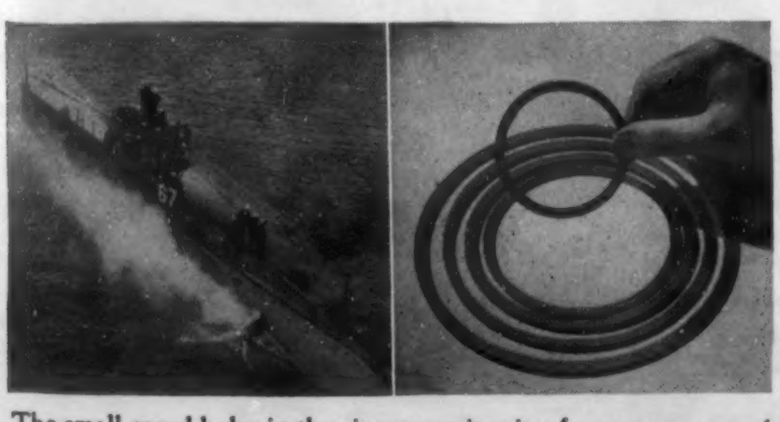
Unhampered by tradition, the designers of communications equipment have taken full advantage of all developments in materials and production methods. It is of particular significance, therefore, that zinc alloy die castings have found such wide use in the manufacture of communication and allied products.

The wartime counterpart of the communications industry—the U. S. Army Signal Corps—is profiting by pre-war advancements in telephone production. For example, the EE-8-A field telephone utilizes the six zinc alloy die castings shown at the bottom of the above illustration. These castings were adopted only after exhaustive testing in competition with parts produced by other methods and of other materials.

Post-war designers please note.

5 IN 1

Pictured below are five bezels for gauges on submarines. They are die cast of zinc alloy and, at first glance, you may ask why. The answer is elimination of scrap loss—a major problem in all metal production today. Actually, by die



The small cored holes in the rings permit grip of a spanner wrench for assembly

THE New Jersey Zinc ALLOY POT

A publication issued for many years by The New Jersey Zinc Company to report on trends and accomplishments in the field of die castings. Title Reg. U. S. Pat. Off.

METALS AND ALLOYS EDITION **No. 7**

casting all five rings in a single die, they are produced at little more expense than would be involved in die casting the largest ring alone. The individual rings are broken off the gate and the small amount of metal which joined them is remelted and reused.

Compare these savings with the scrap loss involved in the alternative method of stamping from sheet metal, and you can understand why the die casting process was selected.

BAKED FINISHES FOR ZINC ALLOY DIE CASTINGS

Almost any known type of finish can be applied on zinc alloy die castings. The wartime shortage of electro-plating materials has, however, focused attention principally on organic coatings, of which there are many types to meet specific service requirements of die castings. In the case of baked finishes on zinc alloy die castings, the relatively low melting point of the alloy should be kept in mind. Finishes on zinc alloy die castings should not be baked at temperatures higher, or for periods longer, than indicated in the table below.

The subject of finishing is fully covered in the bulletin "The Finishing of Zinc Alloy Die Castings and Rolled Zinc." A copy will be sent to you upon receipt of a request on your Company letterhead.

MAXIMUM TEMPERATURE —°F. FOR TOTAL BAKING TIME OF

Alloy	*½ Hour*	*1 Hour*	*2 Hours*	*3 Hours*
* Zamak 2†	325	275	250	250
Zamak 3††	425	375	325	300
Zamak 5†††	425	375	325	300

* Trade Mark Reg. in U. S. Patent Office
† Corresponds to A.S.T.M. Alloy XXI, S.A.E. No. 921
†† Corresponds to A.S.T.M. Alloy XXIII, S.A.E. No. 903
††† Corresponds to A.S.T.M. Alloy XXV, S.A.E. No. 925

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ing solution is applied by spraying sheet or strip continuously fed to the phosphating machine. A very fine-grained coating is obtained which will withstand the drawing, bending, and rolling operations encountered in the manufacture of caps, crowns, and cans.

—V. M. Darsey, *Proceedings*, Am. Electroplaters' Soc., 1942, pages 59-61.

Columbium Steel— High Temperature Properties

Condensed from "Archiv Eisenhüttenwesen"

The influence of the ratio of columbium to carbon, the influence of quenching and drawing temperature, and the effect of structure in columbium steels was investigated.

It had been previously established that the creep strength in hardened steels increases considerably as soon as the columbium to carbon ratio exceeds 8:1. This was also confirmed for rolled unhardened steels. No indication of a brittle fracture was found in long-time creep tests in steels with columbium contents greater than 10 times the carbon contact.

Alloys with a 4 per cent Cb and increasing carbon content revealed a particularly favorable effect of columbium on creep strength; this is ascribed solely to the iron columbide. Thus it is possible to reduce the columbium content to 0.2 per cent if, at the same time, the carbon content is lowered correspondingly, without impairing the creep strength.

The sulphur content exerts an unfavorable influence similar to that of carbon in iron-columbium-carbon alloys. An alloy with 0.2 per cent Cb and 0.005 per cent S, and also up to 1 per cent Si, had a creep strength of 67,000 lbs. per sq. in. at 925 deg. F. after the most suitable heat treatment.

The investigation has shown that in order to obtain a high creep strength the columbium content can be held very low for a definite composition.

—W. Peter, *Arch. Eisenhüttenw.*, Vol. 15, Feb. 1942, pp. 364-368.

Solubility of Metals in Mercury

Condensed from "Bell Laboratories Record"

Since mercury finds many applications in industry, particularly in the telephone industry, its effect on other metals used in contact with it is of importance.

The solubility of metals in mercury is generally slight. Bell Laboratories have a new method using a circulating still. Mercury is evaporated from a boiler into a condenser from which it flows down through a bulb packed with scraps of the metal being tested and back into the boiler. The bulb is kept at a constant temperature of 100 deg. C. (212 deg. F.).

As the mercury moves slowly, it becomes saturated with metal which precipitates in the boiler. After the requisite test time, the mercury is evaporated and the residue recovered for chemical analysis. The solubilities are only accurate within a factor of three due to the uncertainty of the exact amount of mercury circulated:

Silver	0.0018 g./g. of mercury
Copper	0.00013
Nickel	1.4×10^{-7}
Platinum	4.6×10^{-9}
Iron	5×10^{-11}
Stainless steel*	5×10^{-11}

* analysis not given

The surfaces of silver, copper, nickel and platinum are easily wet and remain covered with a fluid film of mercury, while a layer of solid amalgam is formed at the surface of contact. Silver amalgam forms readily. Copper soaked for a few months in mercury at 100 deg. C. (212 deg. F.) disintegrates completely into amalgam. Nickel and platinum black are left behind when the mercury is distilled off.

It is believed that the metal is somewhat more soluble than the amalgam; so, as it slowly dissolves, it is reprecipitated as the amalgam which retards further attack. However, there appear to be relations between the solubility and the speed of disintegrative processes which affect the service life of mercury switches (including formation of solid amalgam and in some cases intercrystalline attack of the metal).

In addition to the metals included in this test, information is given on others: Lead, tin, zinc and cadmium are sufficiently soluble to alter the properties of the mercury; tungsten seems inert but this may be due in part to the protective action of adherent oxide.

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Although the method used is devised primarily for mercury, it should be adaptable to a wider field in the determination of low solubilities of metals.

—C. H. Prescott, Jr., *Bell Labs. Rec.*, Vol. 21, Dec. 1942, pp. 104-107.

Fatigue Strength of Copper Alloys

Condensed from "Engineering Inspection"

As compared with ferrous alloys, relatively little work has been done on the fatigue strength of copper alloys. Present tests were made on R. R. Moore type specimens in rotating beam machines. A speed of 3500 r.p.m. was used in most cases, although some were tested at 1600 r.p.m. (a bronze tested at both speeds showed a negligible speed effect).

Alloy	Condition	Tensile Strength, lbs. per sq. in.	Endurance Strength lbs. per sq. in.
Tough pitch copper	hard	48,800	17,000
85-15 brass	light	44,700	20,000
63-37 brass	hard	72,200	22,700
Signal bronze	hard	62,400	32,700
Phosphor bronze (grade C 0.08% P)	½ hard	66,000	30,000
	hard	81,000	34,700
	extra hard	110,300	30,000
Tobin bronze	hard	69,600	23,700
Everdur 1010	soft	59,600	18,800
	¼ hard	66,600	31,500
	½ hard	74,900	30,500
	hard	97,100	33,600
Beryllium-Copper	heat treated 1½ hr. 575°F.	186,900	55,000
Chromium-copper with 0.9% Cr	hard	72,800	25,800
	heat treated 3 hr. 850°F.	76,800	28,000

A pointed tool finishing with 2 or 3 cuts about 0.002 in. deep was used to minimize work hardening of the surface. However, appreciable work hardening or introduction of compressive stresses did occur as shown by the fact that annealed Everdur at 21,500 lbs. per sq. in. stress had to have about 0.001 in. of metal removed by abrasive polishing before the effect of the machining became insignificant (about 20 million cycles to fracture as machined compared with about 2,000,000 cycles after removal of 0.001 in. or more). Various polishing techniques were employed but in all cases, the specimens were finished with a longitudinal polish using a suspension of Alundum 600 in kerosene or water.

Endurance strengths at 300,000,000 cycles for some of the alloys tested are shown in the Table. (The original paper gives complete details on grain size, final reduction, analysis, mechanical properties, etc.)

Results on the effect of cold work indicate that comparatively little initial working rapidly raises the endurance limit, while further working produces less effect and may even reduce it, perhaps as a result of increased notch sensitivity (scatter also frequently increases with increasing amounts of cold work).

In the case of precipitation hardening alloys, the effect of precipitation is not nearly as great on the endurance strength as on the tensile strength; also considerable scatter may be obtained. Both chromium-copper and beryllium-copper appear very sensitive to variations in heat treatment; therefore, the results obtained on beryllium-copper in this work where samples were laboratory treated under closely controlled conditions and carefully polished are undoubtedly higher than would be obtained on commercial material.

—A. R. Anderson & C. S. Smith, *Engineering Inspection*, Vol. 7, Apr.-June, 1942, pages 15-21.

NE Steels Used in Trucks

Condensed from "Steel"

The Autocar Co. made some tests on NE 8744. A 4-in. square billet was forged down to 2¾ and 1-in. round stock. The ladle composition was 0.41 C, 0.87 Mn, 0.019 P, 0.016 S, 0.28 Si, 0.49 Cr, 0.57

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Ni, and 0.25 per cent Mo.

After normalizing, the 2¾ in. round had a hardness of 223-269 Brinell and the 1-in. stock, 241-262 Brinell. Hardening from 1525-1550 deg. F. with an oil quench increased the hardness of the former to 341 Brinell at the surface and 321 in the center, and of the latter to 534-555 Brinell at the surface and 514 at the center. When the large specimens were quenched in brine, the surface hardness was 514 Brinell.

Drawing at 900 deg. F. resulted in a surface hardness of 3-2-311 Brinell in the 2¾ in. section quenched in oil, 363-388 in the 2¾ in. section quenched in brine, and 375-388 in the 1-in. section quenched in oil. When drawn at 1,000 deg. F., hardnesses were 269-285, 341-363, and 352-365, respectively. A temperature of 1,100 deg. F. gave 255-262 (255 at center), 302 (269 at center), and 302 throughout, respectively.

This steel has been used to replace S.A.E. 3140 in. spring cross shafts. The parts are heat treated as 1¾ in. diameter bar stock, then machined. Quenching in oil from 1550 deg. F. resulted in a hardness of 477-514 Brinell. A draw at 1175 deg. F. brought the hardness down to 277-302 Brinell. In another batch, the hardness as quenched was 555-561 Brinell, and a draw at 1250 deg. F. was required to lower the hardness to 269-293 Brinell.

When used to replace S.A.E. 3120 and 3125 for spring clips and bolts, the 1-in. NE 8744 bar stock is oil quenched from 1525-1550 deg. F. and drawn at 1175 deg. F. to 269-293 Brinell. Machining follows.

When NE 8744 is used to replace S.A.E. 4340 for main shafts, 2¾ and 2⅜ in. rounds are quenched in brine from 1550 deg. F., drawn at 1100 deg. F., and machined.

A trial lot of rear-drive axle shafts was produced from NE 8749 replacing S.A.E. 4340. These were made from 2 3/16 in. diameter bar stock which was machined before heat treating. Shafts were quenched in oil from 1550 deg. F., producing a hardness of 550-601 Brinell. A draw at 840 deg. F. reduced this to 415-429 Brinell.

When ball bolts were made of S.A.E. 2512, they were carburized all over and drawn at 525 deg. F. to develop sufficient toughness and shock resistance. Ball bolts of NE 8620 are copper plated to stop carbon penetration at the neck section. They are carburized at 1700 deg. F., cooled in the carburizing boxes, reheated to 1550 deg. F., quenched in oil, and drawn at 300 deg. F.

These ball bolts are about 1¾ in. diameter in the ball and 1 in. in the neck section. Case hardness of the ball is 61-62 Rockwell C. Core hardness at the neck section and in the taper section below the neck is 21-25 Rockwell C.

—W. J. Diederichs, *Steel*, Vol. 111, Nov. 30, 1942, page 62.

Corrosion of Magnesium Alloys

Condensed from "Metal Industry"

The increasing range of applications of magnesium alloys in aircraft production has led to the study of their corrosion resistance to various agents as well as to atmospheric exposure. The idea that they are much less resistant than other alloys has been abandoned.

Initial reaction in the atmospheric corrosion of magnesium forms a film of magnesium hydroxide over the surface. This causes an increase in weight and the rate of gain is high when the relative humidity exceeds 90 per cent as the film absorbs moisture, carbon dioxide, and sulphur dioxide. At constant humidity, magnesium specimens show a linear weight increase time relationship. Impurities have little effect on atmospheric corrosion.

Corrosion

Magnesium is rapidly dissolved by solutions of hydrochloric, sulphuric, and nitric acids, though hydrofluoric acid (in concentration greater than 5 per cent) has practically no action on it. It is resistant to the action of chromic acid if "foreign" anions such as chloride, sulphate or nitrate are not present.

A review of research concludes that when magnesium corrodes in solutions of sulphuric or hydrochloric acids, an inhibitive, porous, hydride film forms on the metal surface and metal dissolution proceeds at the base of the pores. Rotating specimens in acetic acid solution increases the corrosion rate. Sugar additions decrease it. Oxygen, acting as a cathodic depolarizer, in acetic and chloracetic acids, increases it.

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On the other hand, no molded plastics have yet been developed that equal metals for surface hardness, heat resistance, rigidity or structural strength per unit of area. Conventional molding methods require expensive molds and high heat and pressure limiting them to production of relatively small objects in relatively large quantities.

In short, there will be many a postwar job where metals will be a clear and obvious first choice.

There will be many other postwar jobs which logically call for plastics.

There will also be many occasions when plastics and metals will work together on the same job.

And there will be other times when a materials engineer will be hard put to make a choice.

Frankly, as one of the nation's largest producers of plastics, Monsanto would rather lose some of those close decisions than win a job which plastics could not handle. In the long run, one such misapplication can lose more business for plastics than losing a dozen close decisions. Monsanto Chemical Company, Plastics Division, Springfield, Massachusetts.

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The corrosion of magnesium in sodium chloride solutions is a simple magnesium solution and hydrogen evolution process. Oxygen has no effect on the rate and the hydrogen liberated is chemically equivalent to the loss of weight in the metal. The effect of impurities on the corrosion rate by salt solutions is not fully understood and the mechanism is a controversial matter.

Magnesium is not attacked by solutions of fluorides, chromates, or phosphates, but in other salt solutions corrosion proceeds and if the pH of the liquid is higher than about 6, a film of magnesium hydroxide forms. This film being porous retards but does not completely stifle the corrosion rate. In ammonium chloride solutions, where the initial pH is less than 6, the film is not formed and corrosion is rapid.

Alloying Additions

Aluminum added to magnesium decreases corrosion resistance. Binary magnesium-aluminum alloys are attacked by sodium chloride solution at points where coring has occurred. The magnesium-rich cores in dendritic cast structures are apparently anodic to the boundaries of the dendrites. The action of the added aluminum seems to be to reduce the cathodic polarization.

Boyer and Morioka found magnesium-base aluminum alloys to be less resistant than as-cast material. Boyer also found that precipitated alloys corrode at a rate between that of as-cast and solution treated specimens, but Sawamoto claims that fully precipitated specimens are more resistant than as-cast.

One of the most important discoveries in the history of the metallurgy of magnesium is that the addition of as little as a few tenths of 1 per cent of manganese to magnesium considerably increases corrosion resistance. The addition of 0.15 per cent Mn to an alloy containing 5 per cent Al more than offsets the accelerating action of the aluminum. It probably forms an inhibitive film of hydrated oxides of manganese.

Zinc is said to reduce the corrosion rate of magnesium and magnesium-aluminum-manganese alloys.

Search for an alloy very resistant to the action of sea-water has resulted in the conclusions that: Alkali metals, antimony, cadmium, tin and copper accelerate the corrosion rate, while beryllium, calcium, tin and zirconium retard it. The effect of chromium is doubtful, lead has no effect, and silver retards in chloride solutions and accelerates in atmospheric exposure.

Protective Treatments

Magnesium-base alloys can be protected from corrosive attack by surface treatments or paint. They can be electroplated but as the coatings are porous they cause increased corrosion of the basis metal.

Two processes are outstanding because of the protection afforded and the simplicity and low cost of operation. An acid chromate bath consisting of a solution of 150 grm. potassium dichromate and 200 c.c. nitric acid (sp. gr. 1.42) to each litre of water is operated at room temperature. Parts are immersed from 10 to 90 secs., drained, washed and dried. An immersion and draining of 15 secs. each is recommended for "Elektron" AM 503. Aluminum containing alloys should be drained from 30 to 45 secs.

The films, in color from brassy to straw yellow, form excellent paint bases in addition to their protective value.

Some metal dissolution occurs, not more than 0.0005 in. per surface, but for parts machined to fine tolerances an alternative process may be used.

In the R.A.E.-half hour hot bath, the cleaned degreased parts are immersed in a boiling solution of 15 grm. potassium dichromate, 15 grm. ammonium sulphate to each litre of water for ½ hr. Sufficient aqueous ammonia is added to raise the pH value to the optimum range of 5.7 to 6.1.

The coat of protective film is black on aluminum alloys and bronze on magnesium-manganese. It is a good paint base though not as good as the acid chromate film. It is usually only applied to the aluminum-containing alloys as conditions for its application to the magnesium-manganese are rather critical.

Paint adhesion directly to magnesium-base alloys without either of these baths is poor. If a primer pigmented with zinc is used, almost any good top coat gives protection.

Welded Tanks for Aircraft

Tanks for gasoline and oil in aircraft are of welded construction, treated in the acid chromate bath on completion. A cartridge containing calcium chromate in a fabric bag is located in the lowest point of the tank to prevent corrosion by the water which contaminates gasoline and oil.

The substitution of magnesium alloy tanks for coolants in place of brass tanks would save weight. The hot solutions of ethylene glycal (100 deg. C. 212 deg. F.) attack them but 1 per cent potassium fluoride added to the solution largely prevents corrosion. The addition of sufficient alkali so that the pH lies between 8 and 10^{21} makes protection more nearly complete, especially if other metals are present.

Methyl alcohol of high purity will dissolve magnesium and its alloys but the addition of small amounts of ammonium oleat inhibits the attack.

Solutions of anhydrous methyl alcohol in equal volumes of dry ethyl alcohol used for de-icing purposes attack magnesium alloys. This can be prevented by the addition of 0.2 per cent oleic acid and 1.0 per cent 0.880 ammonia.

If magnesium alloy parts are incorporated in composite components where serious risk of galvanic corrosion arises, one of the following precautionary methods may be used:

(a) Insulation by means of suitable washers or bushes.
(b) Avoidance of electrical contact of magnesium alloys with copper-contain-aluminum alloys.
(c) Use of cadmium plated mild steel bolts, instead of duralumin or anodized duralumin, where metal to metal contact is unavoidable.

—C. J. Bushrod, *Metal Industry*, Vol. 61, Nov. 20, 1942, pages 324-326.

Notch-Effect in Design

A Composite

Since most commercial parts have shoulders, keyways, and other irregularities in shape, the effect of notches is always of practical importance, especially to the designer. Two papers by the same authors, presented at the recent National Metal Congress, provided a wealth of useful data on notches.

Sachs and Lubahn *(Amer. Soc. Metals, Preprint No.* 8, Oct. 1942 meeting) tested several 0.4 per cent C low alloy steels after various heat treatments (most tests were on S.A.E. 2340). Regular tensile tests indicated that the most favorable combination of high strength (240,000 lbs. per sq. in.) and high ductility (12% elongation, 55% contraction of area) was obtained after tempering at 600 deg. F.

However, practical experience indicates that steels are sensitive and prone to premature failure when treated to such a high strength. In other words, the performance of a steel in practice involving stress raisers and sudden loads cannot be judged by the results of regular tensile tests.

Notch Brittleness vs. Ultimate Strength

The notched specimens were provided with circular, very sharp, V-shaped notches. The notch strength is the maximum load divided by the original cross-sectional area of the notched section, while notch ductility is the reduction of the cross-sectional area of the notched section after failure. Samples tempered at 800 deg. F. or higher gave as consistent results as unnotched specimens, but tremendous scattering was observed for lower tempering temperatures.

For a given notch, the ratio between notch strength and ultimate strength depends only upon the notch ductility. Bars having a notch ductility over about 5 per cent possess a practically constant ratio of 1.25 for a 30 per cent notch and 1.6 for a 65 per cent notch. On the other hand, notch-brittle bars with notch ductility of 1 per cent or less may have a notch strength ratio anywhere between a very low value of about 0.2 and a value close to that of the ductile specimens.

The notch ductility decreases with increasing notch depth, at first rapidly, then more and more slowly, and apparently reaches a minimum value at a notch depth of about 50 per cent. The notch ductility decreases with increasing strength and becomes practically zero at strengths for which there is still a very high (unnotched) reduction of area. So, the unnotched ductility has apparently little re-

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lation to the notch ductility of deeply notched bars.

If the notch ductility of a deeply notched specimen is over about 2-3 per cent, the notch strength increases almost linearly with the area removed by the notch, so the limiting 100 per cent notched condition would have a notch strength 1.7-2.0 times the ultimate (unnotched) strength. The relationship of notch strength to notch depth could not be definitely established for notch brittle conditions because of the scattering of results. Stress concentration appears to be a maximum for a notch depth of about 50 per cent.

The notch strength does not indicate brittleness. The notch ductility reaches a minimum value after tempering at 600 deg. F. This behavior correlates with the results of impact tests which also show a minimum toughness after a 600 deg. F. temper.

The effect of quenching from higher temperatures (1600 and 1750 deg. F.) was not visible in the unnotched tensile values but the notched samples showed that the region of notch brittleness extended further in the direction of higher tempering temperatures when the samples were quenched from higher temperatures. *Here again is an indication of the inability of ordinary tensile tests to reveal the practical performance characteristics of a material, whereas these differences are more readily distinguished by a notched bar tensile test.*

For a given tempering temperature, the ductility of a large specimen (2¾ in rd.) with a 95 per cent notch was considerably less than that of a small specimen with a 65 per cent notch. Consequently, the larger bars became brittle at a tempering temperature about 150 deg. F. higher than the smaller bars. In other words, a large section has a considerably higher tendency towards embrittlement by notching than a small section.

Notched Tubing

The same authors *(Amer. Soc. Metals, Preprint No. 7,* Oct. 1942 meeting) also investigated the effect of notches on tubing simultaneously to circumferential and longitudinal tension. Tests were made on S.A.E. 2340, heat treated from 1450 deg. F. The notched specimens had a 45 degree longitudinal notch reaching over the total cylindrical length and having a depth between 30 and 40 per cent of the thickness.

Tests on unnotched tubing tempered at 400-1200 deg. F. showed an ultimate strength slightly higher (about 5%) than that of cylindrical bars heat treated in the same way. On the other hand, the ductility values in the circumferential direction were much lower than those of cylindrical test bars.

At the higher tensile strengths, the tubing showed a reduction of area of only a few per cent as compared to over 50 per cent for the bars. The discrepancy is less pronounced at lower strengths, about 150,000 lbs. per sq. in.

However, the notch strength curve for the various tempers differs considerably from that for cylindrical bars. There is a gradual decrease of notch strength with increasing tempering temperatures. Below about 155,000 lbs. per sq. in. the notch strength is practically the same as the ultimate strength of the tubing; in this range the contraction in area is 3 per cent higher, indicating a ductile condition.

At about 190,000 lbs. per sq. in. the contraction in area of the notched specimens is practically zero and the notch strength is close to the yield strength of the unnotched tubing. At still higher strengths, the notch strength decreases to about 70 per cent of the ultimate (unnotched) strength.

Less scatter was observed in the brittle range with tubing than with cylindrical specimens. The results clearly show that S.A.E. 2340 becomes noticeably brittle if heat treated to 150,000 lbs. per sq. in. or higher and subjected to internal pressure in the form of notched tubing.

Double notched tubing (one notch inside, one outside) showed no greater tendency toward embrittlement than single notched tubing, but the notch strength values were considerably higher for the double notched specimens. Notch strength values determined for tubular specimens machined from rod agree closely with those of tubing. Therefore, notch sensitivity in the transverse direction of the rod is no greater than that in the circumferential direction of tubing.

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CONTENTS

Detecting Cracks in Castings

Condensed from "Foundry Trade Journal"

In a paper "The Testing of Wall Thicknesses of Castings" by Thornton and Thornton, *Foundry Trade Review,* Oct. 16, 1941 a method of determining the thickness of casting walls from one side only by an electrical method was described. An inquiry was made as to whether the method might be adopted for the detection of cracks in castings.

While the method had been applied for the detection of cracks some years ago, the work was of preliminary and experimental nature on fatigue cracks in shafts, and the detection of broken strands in wire ropes. The method is essentially that of comparing the resistance of the metal wall under test, with that of similarly shaped wall of the same material and which is known to be free from flaw.

No knowledge of the specific resistance of the material is required. Current, invariably under 10 amp. for castings, is supplied by a 6 or 12-volt battery to two current contacts held against the wall under test and spaced from 1 to 12 in. apart. With the majority of castings, the current contact spacing is 2 to 3 in.

From a calibration current-thickness curve (if a flaw is present use the effective thickness) the condition of the wall under test is determined. The contacts are made on the wall under test by means of spring-controlled rotating points.

As no absolute measurement of the conductance of the metal of the wall under test is made, the method is essentially one of comparison. Where the contact spacings are so wide that the current flow is for all practical purposes two dimensional, *i.e.,* when the ratio of current contact center distance to wall thickness is from 8 to 10, the curve connecting current and thickness is a straight line passing through zero. It is only necessary to make one actual measurement of wall thickness by caliber or drill test to establish the curve for the particular metal under test.

—B. M. Thornton, *Foundry Trade J.,* Vol. 68, Nov. 26, 1942, pages 277-278.

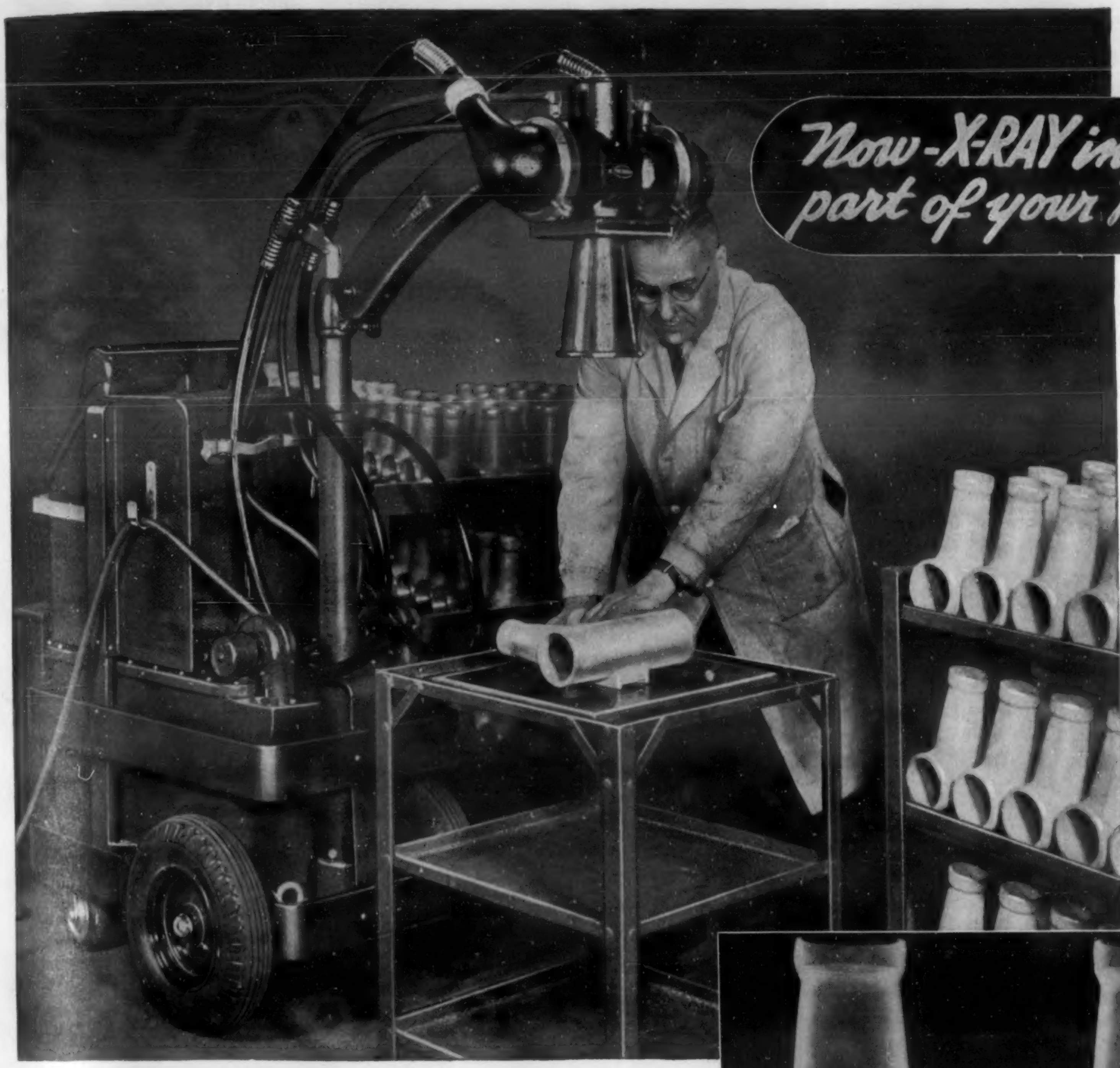
Interpreting Steel Specifications

Condensed from "Metal Treatment"

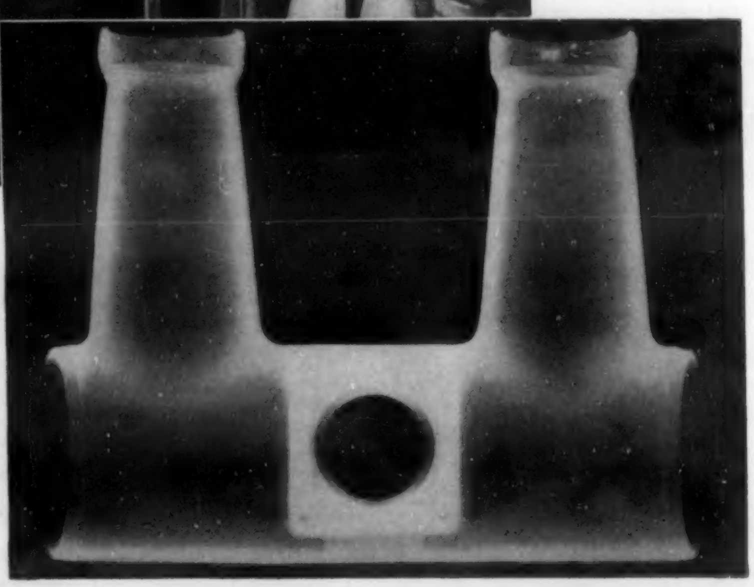
Non-essential, vague and irrelevant requirements are to be found in many steel specifications. The "temper bend" test in some specifications for mild steel, for instance, frequently contains a clause requiring that samples should be heated "to a blood red," as judged indoors in the shade, and then quenched. If this is interpreted to refer to a temperature below 730 deg. C. (1346 deg. F.), no test will ever fail.

In a specification for mild steel, yield point and ultimate tensile strength tests are adequate to determine if strength is satisfactory; elongation or bend tests provide a safeguard that toughness or capacity for cold work are adequate; and requirements for maximum tensile strength insure that the steel will not be difficult to machine.

It is recommended that the requirements for discard should not specify the amount but should state that it should be suf-



Now-X-RAY in any part of your Plant



Powerful Picker Mobile X-ray Unit is ideal for X-ray Inspection of many metal parts at point of production . . .

Picker Industrial Mobile and Stationery X-Ray Equipment fulfills every requirement for production inspection, or spot checking of castings, forgings, welds and spot welds, finished parts or assemblies.

Picker Mobile units have a range of 15,000 volts to 150,000 volts. This provides for radiographing spot welds of thin aluminum sections and up to 6 inches of aluminum, or 1½ inches of steel. Write today for complete details of this unusual x-ray equipment.

Compact, powerful and easily transported on air cushioned rubber-tired wheels, the Picker 150 KV. Mobile Industrial X-Ray Unit is ideally adapted for X-Ray inspection of metal parts at any point of production within the plant, a definite savings in man hours.

PICKER X-RAY PX CORPORATION

300 FOURTH AVENUE, NEW YORK, N.Y. BRANCH OFFICES IN PRINCIPAL CITIES

WAITE MANUFACTURING DIVISION, CLEVELAND, OHIO

ficient to insure freedom from piping. "Specifications must be interpreted with professional skill." A specimen specification for structural steel for boilers is put forward.

—A. J. K. Honeyman, *Metal Treatment*, Vol. 9, Summer 1942, pages 16-24

Radiography in the Foundry

Condensed from "Foundry Trade Journal"

The wave-length of light is about 5000 A.U. at the center of the visible spectrum, while X-rays vary in wave-length between 500 and 1 A.U. This significant difference in wave-length between visible light rays and X-rays holds the explanation of the latter's ability to penetrate material opaque to ordinary light. Any radiation having a wave-length approximately 1/1000th that of ordinary light will slip past molecules of matter in much the same way as light darts through the interstices of Venetian blinds.

The wave-length of the rays decreases, and conversely their penetrating power increases, with increase in the exciting voltage. The potentials necessary for penetrating up to 5 in. of steel are of the order of 90,000 to 300,000 volts.

Before X-ray examination can become a useful instrument in castings inspection, foundrymen must establish an elastic criterion of acceptance or rejection. By this it is meant that a particular casting, having six blowholes instead of a maximum of three, should not necessarily be rejected, but rather that it should be judged, by competent interpreters, with consideration for the size, type, amount, and position of the inclusions, and taking into account the ultimate service that will be required of the finished casting.

Difficulty has been experienced in one foundry with certain castings in copper-nickel. The trouble was due to temporary lack of supplies of magnesium for deoxidizing purposes. Various substitutes for magnesium were tried without success and, finally, manganese-boron was suggested. Radiographic examination showed that a casting that had not been deoxidized contained round gas inclusions while another (deoxidized with manganese-boron) was much cleaner.

A good deal of experimental work has been done by the author on the application of refractory vitreous enamels to cast iron. Some enameled cast iron pipes gave rise to vigorous and repeated "boiling" or bubbling after the enamel had fused. Many representative pipes were subjected to X-ray examination and it was soon established that bad blistering was invariably accompanied by bad blowholes within the walls of the casting concerned.

Many auxiliary uses for the X-ray equipment could be made by an interested foundryman. Samples of coke might be radiographed and compared with a standard to determine the degree of cellular denseness. The author has profitably examined welded foundry cranehooks and slinghooks before placing them in use, and disclosed subsurface defects of a highly undesirable character.

—W. Montgomery, *Foundry Trade J.*, Vol. 68, Oct. 22, 1942, pages 159-170.

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

New Device for Fastening Two Parts

A new device for fastening two parts together is the Rosan locking system of threaded inserts and studs. The basic item is a simple ring with serrations inside and out. The stud is installed by customary methods and the serrated ring forced into place over interlocking serrations built into the stud head, making a tight fit flush with the surface of the material.

Similarly, the insert developed by Rosan may be locked in place by the same interchangeable ring. They are manufactured under license by *Bardwell and McAlister, Inc.*, Hollywood, Calif.

The insert is stronger than the bolt that is screwed into it when installed in magnesium alloy and aluminum alloy. A bolt, lock nut and hammer are the only mechanical aids needed, though a threaded tool and lock nut to install the insert and a driving tool to force the ring into place are available.

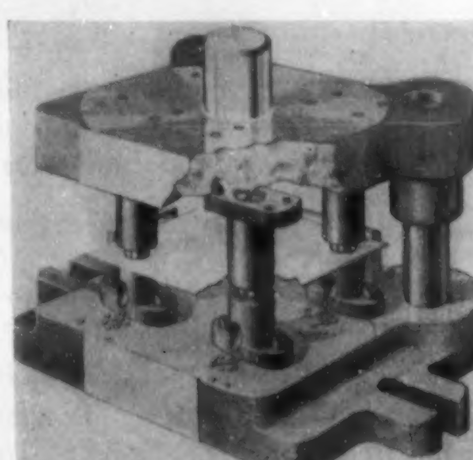
Refrigeration for X-ray Machines

A refrigerating unit for use with industrial X-ray processing has been developed by *Temprite Products Corp.*, 45 Piquette Ave., Detroit. Often lack of uniformity in the solution temperature nullifies two important factors: immersion time and solution strength.

The Temprite model 555-PD circulates large quantities of controlled temperature water at the recommended 65 deg. F. around the processing solution containers in the development tank. The equipment provides that a large volume of clean controlled temperature for washing the film or plates is always available, because all used water is drained off and not recirculated.

Hole Punching Units for Die Sets

New Wales CD hole punching units for use in conventional die sets have been introduced by the *Strippit Corp.*, North Tonawanda, N. Y. The units are sets of punch and die units. The punch unit half contains a punch with a pilot, holder, stripping spring and a guide; the other half,



of a holder with a slug clearance chute and a die.

Each unit is self-contained and independently mounted to either punch or die shoe. This eliminates the necessity of costly production "down time" and critical tie losses by making every punch or die holder quickly and easily accessible for changing individual punches and dies to instantly replace broken or dulled parts without breaking down the entire die set.

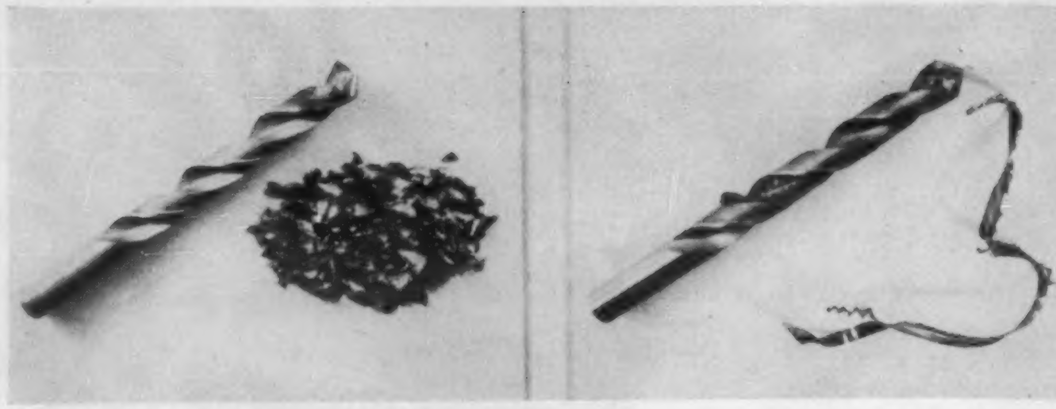
These units are used in either punch presses or press brakes to punch holes from 1/16 to 1/8 in. diam. in metal up to 11 gage.

The accompanying photograph shows four CD units and back gages mounted on a conventional die set.

Free-Machining Invar 36

"The addition of selenium to the 36 per cent nickel alloy, Invar, makes it free-machining, saving as much as 72 per cent in machining time," states G. V. Luerssen, metallurgist, *Carpenter Steel Co.,* Reading, Pa., the company that has developed this improved metal.

The special characteristic of Invar is its low rate of thermal expansion, which is one-tenth that of carbon steel at a temperature up to 400 deg. F. It therefore finds usages in radio and electronic devices, aircraft controls, thermostats, etc. The addition of selenium does not alter its low thermal expansion qualities.



Comparative tests have been made on bars of both the regular and free-machining Invars. In the roughing cuts, burred edges were produced with the regular Invar, which were absent in the free-cutting metal. In the finishing cuts, the newer alloy was much the more superior.

A drilling test was made, using for each grade a block 2-3/16 in. thick. In the case of the regular, after cutting through 1-1/16 in., the drill was badly burned. But a drill cut through the entire block of the selenium Invar without failing. Moreover, there was a marked contrast in appearance of the chips.

In threading test bars of the two varieties, the threads cut on the newer alloy were the smoother. No burrs resulted from machining and drilling the free-cutting grade.

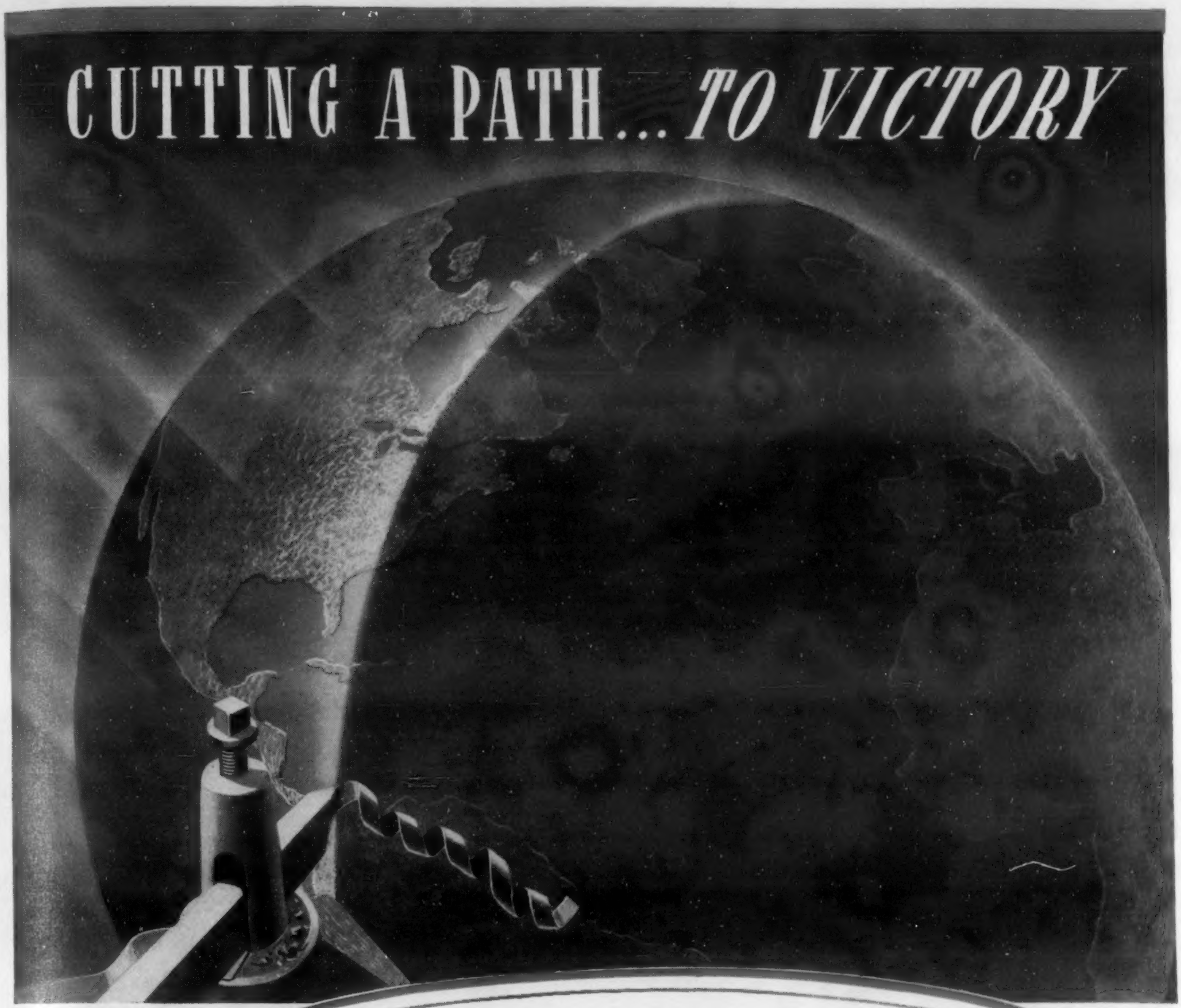
Speeds were also studied. In roughing, a bar 1-in. round was used in both cases, with cut of 3/32 in. and feed of .0055 in. With the regular Invar, the speed was 82.47 surface feet per min., and the tool failed after only a few revolutions. With the free-cut, a speed of 111.67 ft. was used, giving a very good finish. With the feed increased to .0125 in., the finish was still good.

In threading, the regular was worked at 60 r.p.m., and two rough cuts resulted in torn threads. Two finish cuts failed to provide satisfactory threads. With the free-cut Invar, the speed was 188 r.p.m. The same number of rough and finish cuts were made, and threads were greatly superior.

The new alloy is officially named "Carpenter Free-Cut Invar 36."

In the accompanying photograph, the drill at the left cut through a part of the block of regular Invar and was badly burned. But the drill at the right cut through the entire block of free-cut without failing. The chips resulting from the operations are shown.

● A new insulant, Bunatol, has been developed for use with anodizing racks, particularly where used in the sulfuric or chromic process, where rapid insulation breakdown has been costly. The maker, *Nelson J. Quinn Co.,* Toledo, Ohio, claims that Bunatol provides a tough, splendidly adhesive coating that is flexible, does not become brittle, nor crack or peel when the clips are flexed.



FROM the threat of abysmal global darkness, our world is gradually emerging into the Light of Freedom. The prospect of eventual Victory is but a reflection of America's collosal and unequalled capacity for production . . . *a record output that would be impossible without TOOLS!*

• LATROBE is proud to play its role through the development of quality high-speed steels, so vital to Industry's manifold cutting operations.

The service of Latrobe's highly specialized organization is at the command of every tool producer . . . with modern research, skilled engineering and timely technical assistance.

HIGH SPEED STEELS FOR VICTORY

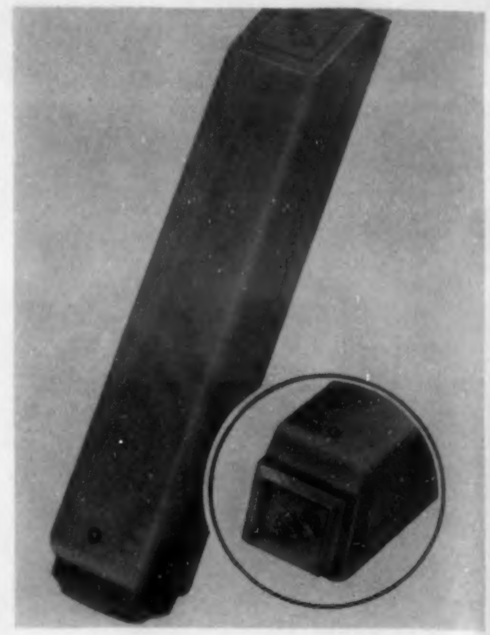
LATROBE

ELECTRIC STEEL COMPANY

MAIN OFFICES *and* PLANT • • • LATROBE • PA•

Inspection and Work Identification Stamps

A new type of etching stamp, "S-22" Synthetic, has been developed by the *James H. Matthews & Co.*, 3942 Forbes St., Pittsburgh.



The maker claims that, unlike rubber and other materials which soon disintegrate when used with acid, this new product is unaffected by acid etching inks. They say that it outlasts the best rubber or ordinary synthetic stamps from three to four times.

● A new greaseproof, non-corrosive paper to protect highly finished metal parts against corrosion has been developed by *Sherman Paper Products Corp.*, Newton Upper Falls, Mass. Called V-26, it eliminates multiple wrapping operations at point of use. The inner ply provides a greaseproof barrier for the retention of corrosion-preventatives used on metal products, while a strong outer ply protects the former against damage in transit.

Constant Temperature Dry Ice Cabinet

Temperatures from —90 deg. F. to 220 deg. F. with a constancy of plus or minus ½ deg. are claimed from a new dry-ice cabinet, made by *American Instrument Co.*, Silver Springs, Md. It is available in two temperature ranges: From zero to —90 deg. F., and from 220 deg. to —90 deg. F.

Temperatures of —65 deg. and —90 deg. are attained in 15 and 30 min., respectively, from an initial temperature of 85 deg. Temperatures can be held at —40 deg. F. and —90 deg. F. in an ambient temperature of 85 deg. F. for 24 hrs. with 40 and 60 lb. of dry ice, respectively.

In the low temperature model, close temperature control is attained by an Aminco Quickset bi-metal thermo-regulator, which, through a solenoid and an electronic relay, operates a damper that allows air to be passed over the dry ice when cooling is needed; or by-passed, when not. In the high-and-low temperature models, the above control is augmented by Aminco Lo Lag electric heaters operated through a silent power relay.

Inspection Device for Tiny Parts

A comparator, used for examining acorn-sized commutators for dynamotors, which supply electric power for aircraft radio equipment, has stepped up production 20 per cent and cut cost 10 per cent at the Mansfield, Ohio plant of the *Westinghouse Electric & Mfg. Co.* This inspection device contains a light bulb, two mirrors and four glass magnifying lenses.

An image of a commutator's surface is reflected on a glass screen after being magnified 22 times the normal size. Inspectors make sure that paper-thin strips of copper and mica are in perfect alignment by comparing the image with vertical lines on the glass screen. Copper and mica strips must be absolutely parallel — a slanted strip could create static in a war plant. Without the magnifiers, women complained of eye strain and headaches.

For peace production, the device is adaptable to setting tiny parts that go into thermostats in electric ranges and irons, examining threaded parts for electrical equipment and checking gages.

Two Induction Heating Units

Two new induction heating units for surface hardening, brazing, soldering and other heating applications requiring localized heat have been put out by the *Van Norman Machine Tool Co.*, Springfield, Mass. The operator merely connects the proper heating coil for a particular job, and sets the heat and quench cycle required.

To change from one job to another, the operator simply changes the work-holding fixture and heating coil and resets the heating cycle to meet the new requirements.

They are available in two sizes, 16 kw. and 32 kw. Advantages are: Uniform hardening, accurate results, increased output, conservation of alloy steels, reduced spoilage, reduction in costs, and savings in time. Average workers can operate the machines.

● "Drei-Brite" is a dry descaling process for steel cartridge or shell cases. It is a revolving table on which is mounted cleaning chambers. Cleaning is in all stages of draft after annealing, the process removing all scale. The surface becomes a very light frosted finish. Compressed air at 10 lb. pressure, steel grit feed and exhaust are controlled automatically. Cleaning chamber covers operate mechanically. The steel grit is returned to the hopper while the dust is removed by exhaust suction.

Monitors for Resistance Welding

The first of a series of standardized flash-welders has been announced by *Progressive Welder Co.*, Detroit, known as Model C, rated at 150 Kva. A feature is the "Flash-trol" monitor, which provides an automatic weld-quality control by eliminating short-circuiting of the flash-welding arc. It "warns" the machine of an impending short circuit in the welding arc. Thereupon the forward movement of the feed platen is interrupted, the platen jumps back a few thousandths of an inch and re-approaches.

An above normal rate of acceleration of the feed platen while performing the weld takes place, thus insuring that the maximum rate of weld completion is automatically employed, without the danger of incomplete welds or line overloads due to short circuiting.


FROM IZOD TO CHARPY TO TENSION IMPACT
"with a twist of the wrench!"
THE NEW
OLSEN IMPACT TESTER
WITH THE
"CHANGE-O-MATIC" HEAD
AN EXCLUSIVE OLSEN DEVELOPMENT
Izod to Charpy to Tension Impact with a twist of the wrench! No longer need you "set-up" for each test; no longer need you add or remove striking edge faces, anvils, etc. . . . merely loosen a lock screw and turn the exclusive CHANGE-O-MATIC HEAD to the desired testing tool surface. In addition, the new Olsen Impact Tester has a completely automatic brake . . . no button to push or level to pull. These are but two of the many features which make this the most completely modern Impact Testing Machine ever built . . . with operating simplicity and testing accuracy assured.
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510 N. TWELFTH ST. PHILADELPHIA, PA.
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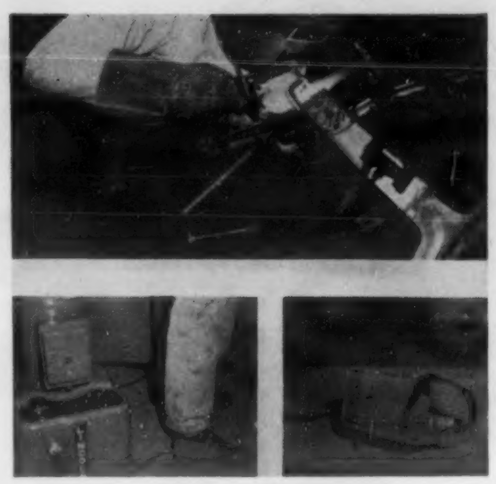
Los Angeles, San Francisco, Seattle
Proving every day that the value of testing depends on the quality of the testing equipment.
Be sure to see the Change-O-Matic Impact Tester at the Metal Show—the finest in Testing Equipment at Booth #277.
OLSEN
IMPACT TESTING MACHINE WITH "CHANGE-O-MATIC" HEAD
IZOD
CHARPY
TENSION
Write for Bulletin #22

Foot Control for Arc Welding



A control strapped to the arc welder's shoe permits very accurate control over the welding arc. He can move around at will, it is almost as light as a shoe, and is a boon to women welders. This, the "Lincoln-control," is made by the *Lincoln Electric Co.*, Cleveland. It is specially intended for aircraft welding, but is applicable for light-gage sheet metal of all kinds.

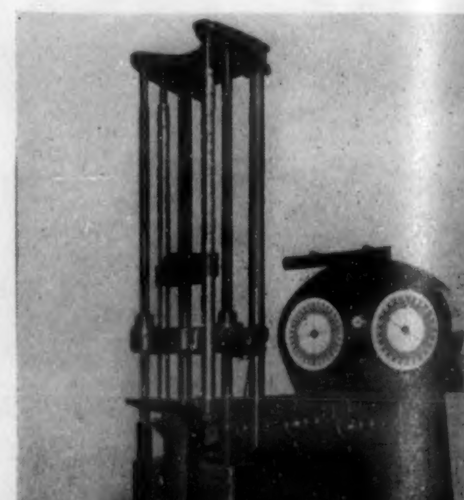
The welding operator merely presses down on the pedal, which moves the pin to operate a current control. More pressure results in increased current. The operator can adjust the arc at any time without changing his position.

An improvement in the quality of the weld results, reducing the danger of the weld burning through or getting poor fusion or penetration.

● A heavy-duty soluble cutting oil that promotes the finish, tool life and cooling formerly required by more than one oil is introduced by *Standard Oil Co. of Indiana*, Chicago. It contains an effective amount of special compounding other than that required for good emulsion. It is stable in storage, mixes easily, does not gum, has anti-rust properties, is non-injurious to workmen and is not susceptible to odor.

Million-Pound Testing Machine

A 1,000,000-lb. testing machine, standing two stories high and handling members up to 18 ft. high for testing either tension or compression, has been built by the *Southwark Div., Baldwin Locomotive Works*, and installed in the new Northwestern University Technological Institute,



Evanston, Ill. It can apply transverse loads up to 1,000,000 lbs. on girders or rigid frames up to 55 ft. wide and 18 ft. high.

Distributed or torsional loads can also be applied by a series of hydraulic jacks and connections to the massive concrete foundation's girders. It has two 20-in. dials with four scale ranges, and is equipped with a load maintainer and an automatic stress-strain recorder.

● To offset labor shortage, the *Timken Roller Bearing Co.*, Canton, Ohio, outfitted a D-2 caterpillar tractor upon which was mounted a Traxcavator to clean out open-hearth furnace slag pockets. The job usually took 30 men from three to six days; with the mechanical equipment, six laborers finished the job in two days. The furnace rebuilding required only 10 days instead of 17 days, and over 1200 tons of steel production was saved.

Conserve tin for Uncle Sam..

"600" Alloy contains no tin, but ... for the majority of bearing problems..

will prove Superior!

● 600 Bearing Alloy is approximately three times stronger than the best cast bearing bronze—*yet it contains no tin.* It develops a lower temperature under heavier loads and higher speeds than the bearing bronzes, and extreme pressure lubricants do not corrode it.

600 is the solution to many difficult bearing problems. It can be drawn or forged and readily fabricated in a great variety of sizes and shapes.

600 Bearing Metal has been successfully used for the past 14 years for:

Gears • Gear Blanks • Bushings • Bearing Pins • Connecting Rods • Worm Gears • Cams • Thrust Washers • Propeller-Shafts • Drive Shafts • Super-Charger Shafts • Truck Transmisions, etc., etc.

Primarily where a bearing is subjected to a reciprocating motion, reduction in weight is essential to keep vibration at a minimum and to assure maximum efficiency. Because 600 Metal is stronger per unit of weight, parts can be made of equal strength out of 600 Metal with a REDUCTION OF 10% TO 35% IN THE WEIGHT OF THE FINISHED PART.

Investigate this superlative bearing metal which contains no tin; thus conserving this critical metal for our war effort.

If you have a bearing problem or want more complete information, please write us

MUELLER BRASS CO.

PORT HURON, MICHIGAN

Annealing by Radiant Gas Heat

For the continuous annealing of the mouth ends of steel cartridge cases from 37 to 102 mm., the *Selas Co.*, Erie Ave. and D St., Philadelphia, has built a series of automatic machines utilizing ceramic-cup radiant gas burners in refractory-lined tunnels, which let down over moving lines of cartridge cases.

Each case rotates about 15 times on an individual spindle during its transit through the annealing tunnel so that uniform preheating, heating and cooling is achieved over the desired area. The metal is annealed to a point several inches below the mouth opening.

Flame does not impinge directly on the cases, hence discoloration is reduced to a minimum. Scaling is prevented because the work is surrounded by combustion products rather than air in all hot zones.

The 24 burners are staggered and each has a built-in needle-valve input adjustment. Thus, heat inputs at various points may be balanced to suit the heat distribution pattern desired. The primer-cup end of each case remains cool at all times. In a 90-in. tunnel, 18 in. are devoted to preheating, 36 in. to full firing and 36 in. to confined cooling.

Similarly Selas machines have been designed for other localized annealing and hardening jobs on other ordnance parts, some utilizing semi-enclosed radiant burners (as described above), others using special open arrangements if refractory-lined heat-concentrating burners of the "superheat" variety.

Tin Recovered From Solder Drosses

Salvaged solder drosses are being remelted at one of the Massachusetts plants of *General Electric Co.* to reclaim tin.

Though the drosses show but little signs of containing tin, a sizeable amount is reclaimed when they are remelted in this bottom-pour, electrically-heated furnace.

Tumble-Spray Metal Washer

A new small parts washer, designed around a special patented endless tumbling belt, is a recent development of the *American Foundry Equipment Co.*, 555 South Byrkit St., Mishawaka, Ind. This batch-type machine receives and discharges the parts through a large front opening.

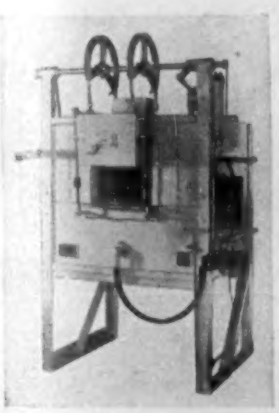
The work is tumbled to expose all surfaces to the powerful cleaning action of the sprays. There is complete access to the parts while in process, and the spray system is handy for cleaning pipes and nozzles.

The machine is especially good for cleaning small screw machine products that can stand a slight tumbling action. Any one of three types of heat may be used, and full automatic controls can be supplied.

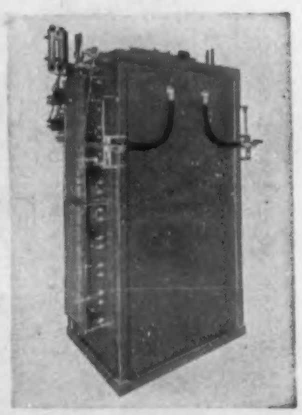
● Celluloid, America's first plastic, is marking its 70th anniversary. Though old, it has many modern uses, such as Celluloid laminated wood propellers. Many small though important aircraft parts are made of it, as are bomb and shell components and torpedo fuses. It is made by the *Celanese Celluloid Corp.*, 180 Madison Ave., New York, N. Y.

"Extra Tough"

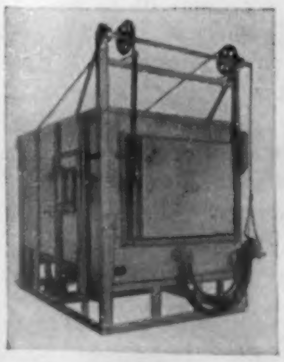
In Hayes-hardened tools and dies, the working qualities of the steel can be developed to the *MAXIMUM!*



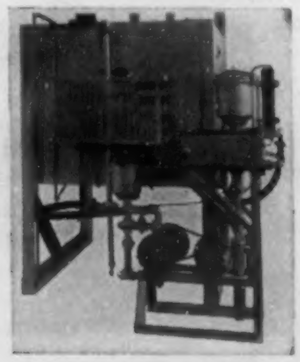
Standard furnace for hardening high speed steel tools.



Special vertical furnace for hardening large broaches up to 7 feet.



Special furnace for hardening large dies.



Special furnace for hardening MOLY STEELS without decarburization.

Request Bulletins

A major advantage of precision atmosphere control—as embodied in "Certain Curtain" furnaces—is the ability to develop the MAXIMUM production life in tools and dies. Greater over-all life, longer runs between grinds, fewer production interruptions—these all help to break the production bottleneck formed by scarcity of available machines.

In permitting ample time at the critical without danger of atmospheric attack, "Certain Curtain" furnaces also speed and safeguard the production of the tools and dies themselves. Thanks to assured safety of operation, output is often increased 35% to 50% per man per furnace, with spoilage reduced to a negligible factor. Especially in heat treating on intricate, specially made work, it is highly beneficial to have the extra protection afforded by the positive "Certain Curtain" atmosphere control.

Discuss with one of our engineers the application of these champion furnaces to your work!

ELECTRIC CERTAIN CURTAIN FURNACES

C. I. HAYES, INC. Est. 1905, PROVIDENCE, R. I.

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Union Nat. Bank Bldg.
HOUSTON

RIDDELL ENG. CO., INC.
Martin Bldg.
BIRMINGHAM

World's Leading Controlled-Atmosphere Furnace

Magnetic Scrap Picker Equals Six Men

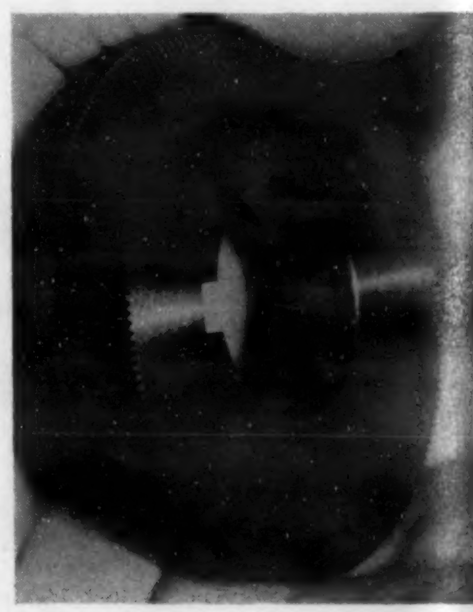
A self-powered magnetic scrap picker, built by the *Timken Roller Bearing Co.*, Canton, Ohio, from odds and ends, is doing the work of six men in gathering up scrap in Timken's railroad yards. In two hours it does the work that three 2-men crews formerly did in 24 hrs.

Mounted on an ingot buggy, it is powered by a Hercules, Ford V-8 diesel replacement engine that drives a 230-volt d.c. generator, which supplies power for the magnet and electric motor drive. The magnet is 39 in. in diam. and can lift 900 lbs. of heavy scrap or 300 lbs. of turnings per load. The box holds 1200 lbs., and the boom has a 12-ft. swing.

● A metal cleaner as a substitute for carbon tetrachloride and which is a volatile water-white methalated hydrocarbon solvent that evaporates has been developed by the *Curran Corp.*, 6 Pleasant St., Malden, Mass. It has a cleaning and dissolving action on gums, oxidized oils, burnishing compounds, etc. It is 14 times faster than naphtha, induces no rusting tendency of ferrous metals, is less toxic than carbon tetrachloride, and is cheaper.

Cutter for Shaving Process for Gears

A shaving process for gears, developed by the *Michigan Tool Co.*, Detroit, involves a cutter that comprises 6408 accurately ground and sharp cutting edges. Each

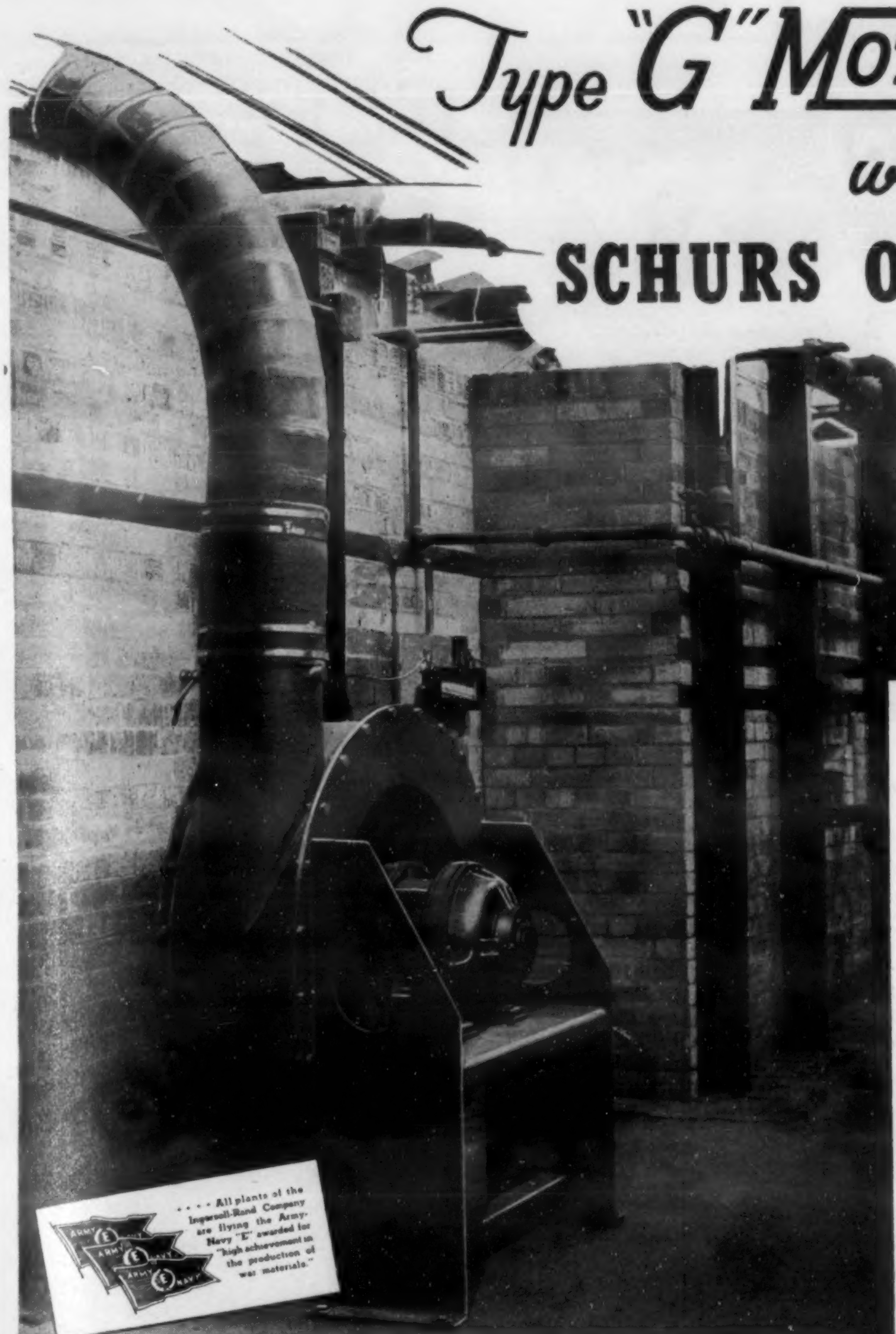


edge is an individual cutting tool that removes its own chip by the crossed-axis shaving principle.

Gears furnished by this process are used extensively in precision instruments for airplanes, ships and many other applications in sizes from ¼ in. up to many feet in diam.

● A new washing machine to remove oil and chips from work, such as machined shafts of standard or special shapes during interprocess operations, has been introduced by *N. Ransohoff, Inc.*, Cincinnati. It can be equipped with perforated baskets for cleaning delicate small parts. The main feature is the special carriage, consisting of V-shaped brackets, which are lined with brass where in contact with the work, to prevent scratching.

Type "G" MOTOR BLOWERS with SCHURS OIL BURNERS



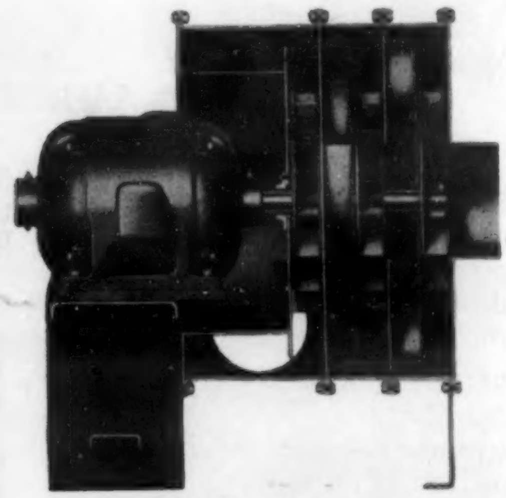
. . . . All plants of the Ingersoll-Rand Company are flying the Army-Navy "E" awarded for "high achievement in the production of war materials."

For a modern firing kiln at its plant in California, the Gladding-McBean Co. selected Schurs oil burning equipment which included the 10-hp Ingersoll-Rand Type "G" MOTORBLOWER shown above. This combustion air blower is playing a quiet but necessary role in the plant's nearly continuous operation and stepped-up production of fire brick, refractory shapes and roof tile.

Specify Type "G" MOTORBLOWERS

PRESSURE:	½ to 2¼ lb.	POWER:	2 to 30 hp.
VOLUME:	100 to 4500 cfm.	BULLETIN:	Form 2671-B

STURDY CONSTRUCTION



Important to all of us is the ability of our nation's manufacturing equipment to stay on the job longer hours with minimum time out for maintenance or repairs. The cross section of the three-stage Type "G" Blower shown above illustrates the sturdy, simple construction which enables these units to keep pace with the most severe operating demands.

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY. 12-225

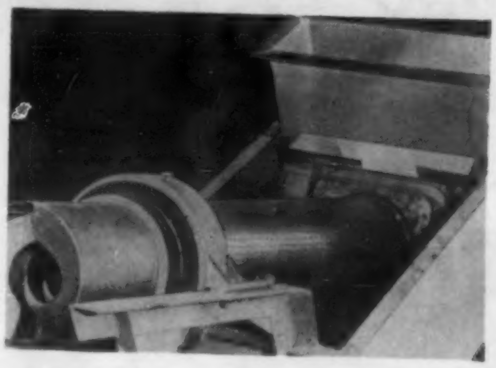
Atlanta	Dallas	Kansas City	Pottsville
Birmingham	Denver	Knoxville	Salt Lake City
Boston	Detroit	Los Angeles	San Francisco
Buffalo	Duluth	Newark	Scranton
Butte	El Paso	New York	Seattle
Chicago	Hartford	Philadelphia	St. Louis
Cincinnati	Houston	Picher	Tulsa
Cleveland		Pittsburgh	Washington

Conveyor from Quench to Pickle

Large quantities of heat-treated parts are removed from the quench by the Spiralveyor, developed by the *Salem Engineering Co.*, Salem, Ohio. Small stampings or forgings leave the discharge end of a furnace and enter the quench. The Spiralveyor will not only remove them but convey them to a pickling unit, 8,000 lbs. per hr.

The unit is a perforated steel tube, 18 in. in diam., through which a screw carries the parts through the tube and out of the quench.

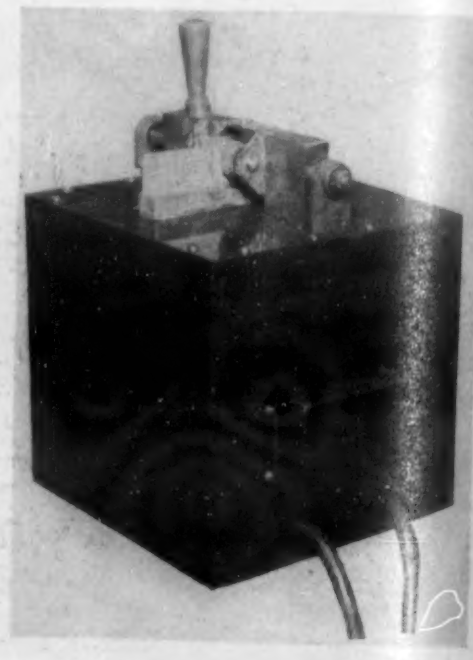
Water is tumbled out of the components and through the 9/32-in. holes of the tube. Thus, parts enter the pickle without diluting the bath with retained water.



● Catalysis now supersedes slow combustion in standard gas analysis apparatus made by the *Burrell Technical Supply Co.*, 1936 Fifth Ave., Pittsburgh. It provides a faster, safer, more accurate method for the determination of the combustible components usually determined in the slow combustion pipette. The gas mixture is passed rapidly through a heated catalyst tube, and oxidation is completed in just a few passes.

Transformer for Silver Soldering

For silver soldering precise work, such as airplane engine thermometers, the No. 1 one-electrode special soldering heater of the *American Car & Foundry Co.*, 30 Church St., New York, is proving efficient.



In this case, the brass case that holds the thermometer is soldered. The equipment is used by makers of precision instruments, and jewelry and optical manufacturers.

The machine is in a box, 9 in. cube, weighing 70 lbs. It is operated by a foot treadle that rests on the floor. Both hands of the operator are free. It is especially adaptable where lower melting solders are used.

● A new rivet sorting machine developed by the *Fisher Body Div., General Motors Corp.*, Detroit, salvages thousands of vital aluminum rivets. They are placed in revolving cylinders, holes in which vary in size; hence they can be sorted according to thickness. Later they are separated according to type, length, head style, etc., all mechanically, three operations in all.

For VISUAL INSPECTION of MATERIALS and PACKAGE GOODS

The *New* Standard Industrial Fluoroscopic Unit is designed for the *visual inspection* of materials and assemblies, Plastics, and many other applications.

Its MANY IMPORTANT USES in war plants and industries speeds vital production, saves man hours, avoids costly delays. This modern, time-saving unit, has an application in your own plant.

Highly recommended for halting sabotage and safeguarding defense plants. One large defense plant employs this Model "D" Unit in its Receiving Department to detect concealed clockwork and possible destructive mechanisms before opening boxes, cartons and packages.

The Model "D" Unit comprises the high tension transformer unit, including an oil immersed x-ray tube especially designed for industrial work: remote controlled fluoroscopic shutters operable by hand levers; and a shockproof Mobile Control Stand.

Capable of continuous operation throughout a 24-hour day, this water cooled unit performs with maximum efficiency without time out. Tubes may be replaced within a few minutes. All parts are easily accessible. Rating 8 MA at 90 KPV continuously.

STANDARD INDUSTRIAL X-RAY FLUOROSCOPIC UNIT

MODEL "D"

Standard X-Ray engineers have designed new, industrial x-ray equipment that is entirely automatic and operable by unskilled labor. Ask for specifications on "Industromatic" X-Ray apparatus.

Write Today for Complete Details

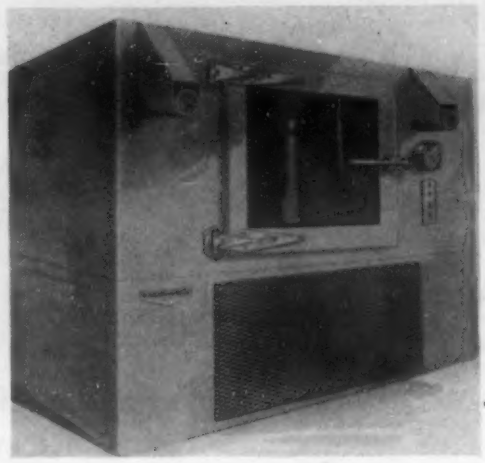
STANDARD X-RAY COMPANY

Pioneers in X-Ray Equipment for over 30 years

General Offices & Factory 1932-42 N. Burling St., Chicago

Sales and Service Depots in all Principal Cities

Testing in Extremely Opposite Temperatures



For testing metals, aircraft parts, etc. to see how they will react under sharp extremes of temperature, the *Kold-Hold Mfg. Co.*, Lansing, Mich., has brought out the "Hi-Low" machine, offered in three temperature ranges: From —60 deg. F. to +170 deg.; from —80 deg. to +170; and from —90 deg. to +170 deg.

The machine is self-contained and requires only a source of electrical power. For the "Hi" side, strip heaters are located in the air stream for defrosting and rapid heating. For the "Low" side, finned type coils are employed. The condensing unit is a 4, 7½ or 10 h.p., 2-stage-air-cooled "Freon-12 or 22" machine, as specified.

● Durashield, a laminated plastic, is being used extensively in the Navy as a substitute for brass, copper or bronze nameplates, tool checks, dial faces and similar marking plates on ships, machinery and metal equipment. It is made by *Plastic Fabricators, Inc.*, 500 Sansome St., San Francisco. It can be die cut, stamped and drilled, and withstands temperatures of 200 deg. F.

Large Lithium Atmosphere Furnace

One of the largest chemically-neutral atmosphere furnaces yet built is at work in the eastern plant of one of the world's largest propeller manufacturers. It was made by the *Lithium Corp.*, 111 Sylvan Ave., Newark, N. J. The muffle, 3 x 3 x 25 ft., had to stand temperatures ranging from 900 to 2,100 deg. F. A rail-roller system of support for the muffle was evolved to facilitate compensation for expansion and contraction.

Sixty-six specially-designed burners are used for even heat distribution. The furnace capacity is 3000 lb. per hr. Dimensions are 8 ft. wide, 10 ft. high and 30 ft. long. It has no atmosphere adjustments.

Clean bright work is obtained at all times, and complete protection is afforded when the work is removed from the furnace.

● No-Spat is a liquid said to prevent adhesion of welding spatter, made by *Midland Paint & Varnish Co.*, Cleveland. It is brushed over the seam and area where spatter may fall. After welding, the spatter may be wiped away, with no chipping or grinding needed. It also tends to minimize rod spatter, and saves much rod metal.

Two New Coolant Strainers

Two special coolant strainers have been brought out by the *Metal Textile Corp.*, Orange, N. J. Model G (the grinder model) has an unusually high capacity through a combination of three filter elements held side by side by thumb nuts, easily removable for quick replacement. It prevents chips or particles from being recirculated in the coolant flow and thus avoids scoring. When installed in the sump tank, before the circulating pump, the strainer also keeps the pump free of chips or lint.

The Metex Model H (single unit) is for use where the size of the coolant tank will not accommodate a triple-unit element. Capacities of Model G range from 15 to 60 gal. per min., Model H from 5 to 20 gal.

WARTIME INDUSTRIES

depend on Quick-setting Self-hardening

PENCHLOR ACID-PROOF CEMENT

REG. U. S. PAT. OFF.

SPEEDY CONSTRUCTION—unusual durability—continued, dependable service...that's what you want in corrosion-resistant equipment. And that's what you *get* when you build with Penchlor Acid-Proof Cement. This tough, long-lasting cement won't tie up your work with the usual delays. It's quick-setting and self-hardening...it's easily handled...no heating required ...no drying delays...no acid treatment needed to set.

You can be *sure* Penchlor is dependable. It has been *proved* by years of the toughest service in a wide variety of corrosion-resistant installations. Decide now to use Penchlor Acid-Proof Cement on your next job of corrosion-resistant construction. You'll get: Long Life...Minimum Repairs...Permanent Mortar Set ...Less Shrinkage...Strong Adherence to the usual construction materials.

Let us give you the complete story of this exceptionally successful acid-proof cement. Return the coupon for the new, *free*, illustrated booklet.

Used by these industries and many others

Acids	Oil
Alum	Paper and Parchment
Bleaching and Dyeing	Pulp
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Explosive	Steel
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I would like to have a free copy of your new booklet No. 6 on Penchlor Acid-Proof Cement.

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Where conditions require a cement of unusual strength and high resistance to abrasion, consider these Penn Salt *resin* cements: *Asplit*, for conditions always acid ...*Causplit*, for alternate acid and alkaline conditions. These are easy to handle and will withstand a wide range of corrosive conditions up to 350 degrees F.

* * *

At your service, without obligation, is the long experience of our engineers in handling acids and alkalis in our own plants. Write fully. Or if you prefer, use the coupon.

Extreme Cold for Shrinking of Metal

Liquid nitrogen, 410 deg. F. below zero, is used by *General Electric Co.*, Schenectady, N. Y., to shrink steel parts used in making electrical apparatus.

The shrinkage allows a diameter clearance of slightly less than two-thousandths of an inch between the steel part (right in the inset of the accompanying photo) and the hollow tungsten carbide cylinder, which is later fitted over it to form a complete punch. The shrunken part expands quickly, forming a strong bond, and the assembled punch is ready for production.

Cutting Torch with Versatile Applications

A new cutting torch which, in addition to plate cutting, will do such jobs as hole piercing, cutting rusty multiple plate, billet deseaming, and cast iron and rivet washing has been brought out by *National Cylinder Gas Co.*, 207 West Wacker Drive, Chicago.

A new mixing principle provides fast preheating, and oversize high pressure oxygen passage permits unrestricted flow of cutting stream for fast economical operation on all thicknesses. A leak-proof high pressure oxygen valve is made possible by the diaphragm that replaces packing ordinarily used. The smooth action of this valve permits "easing in" of the oxygen cutting stream to give better starting control.

The vital parts are made of stainless steel. The torch has the brand name of Rego.

● Ninety heat resistant castings of Meehanite metal make up an intricate 41-ft. diam. distributor plate made by the *American Brake Shoe & Foundry Co.*, New York. It will be installed in the largest vessel for pressure operation yet designed, states *Meehanite Research Institute of America*, 311 Ross St., Pittsburgh.

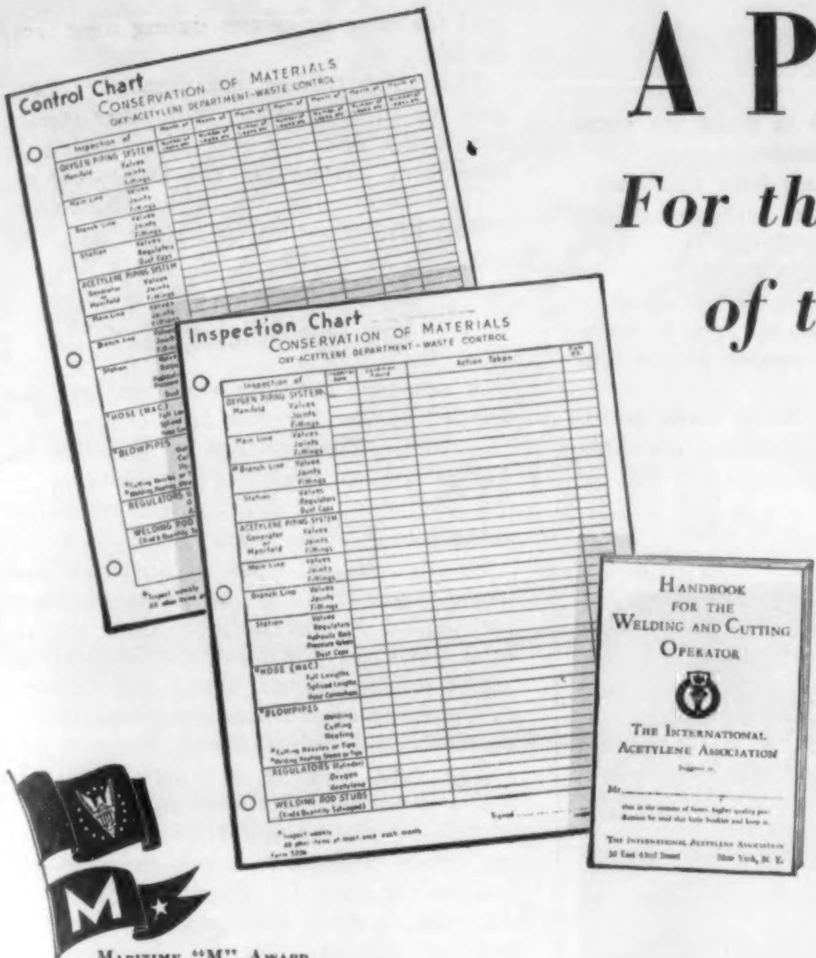
Control for Aluminum Resistance Welding

Greatly simplified construction characterizes a new electronic capacitor discharge resistance welding control for resistance welding of aluminum, announced by *General Electric Co.*, Schenectady. It eliminates much vital material, and facilitates thorough inspection and servicing. It provides the very high currents and short welding time for aluminum, with its low resistance and high heat conductivity.

The control consists of a charging circuit, a discharge circuit, control station, Pyranol capacitors and sequence control, all in one enclosure, with full-length front doors and removable rear covers. Charging and discharge tube circuits are mounted on a single hinged compound base, readily swung out for servicing.

The control station can be removed from the cabinet and attached to the welding machine, allowing the cabinet to be located at some remote point.

● A new metal-washing division has been formed by the *American Foundry Equipment Co.*, 555 So. Byrkit St., Mishawaka, Ind. It will design and build machines for the removal of chips, dirt, grease and oil from machine parts, stampings, etc. Batch-type machines are available; also, large continuous conveyor and monorail-spray types to incorporate any desired sequences of wash, rinse and dry.



A Planned Program

For the Control of Waste in use of the Oxy-Acetylene Process

The greatest over-all losses of oxygen and acetylene come from little things at many points—such as small leaks at fittings, leaky hose, and minor faults of operators, both experienced and new. An effective method for control of such waste must strike at each one of these small points.

Elimination of leaks and wasteful practices requires a planned program, the responsibility for which must be shared equally by management and operators. To help put such a program into effect, the Linde organization suggests the following plan be adopted—modified as needed to fit each shop.

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

1. **Appoint an inspector** to check regularly the piping system, the hose, and the apparatus while the equipment is in operation. Besides soapy water and a brush to test for leaks, wrenches, and a simple repair kit, he should have some form of INSPECTION CHART such as that shown above and a map of the oxy-acetylene system on which to record tests, repairs, and other pertinent information. *Sample copies of this chart (Form 5206), and of a map (Form 5207), will be sent by Linde without charge.*

2. **Summarize the inspection data** on a master CONTROL CHART such as that shown above. This will give plant executives an over-all picture of the waste control program. *Copies of this chart (Form 5205) are available from Linde.*

3. **Co-operation of every operator** should be solicited for the success of this waste control program. To remind operators of the many little ways in which waste can be avoided, Linde will send as many copies as you need of a vest-pocket-sized booklet, published by the International Acetylene Association, that presents the conservation story in a series of illustrated "do's" and "don't's." *Every operator should have a copy of this little handbook.*

The program outlined above will not only help to assure continued adequate supplies of oxygen and acetylene, but should also more than pay for itself in lowered costs and increased efficiency. For samples of the charts described above, and for handbooks for your operators, send the coupon, or ask any Linde office.

The Linde Air Products Company

Unit of Union Carbide and Carbon Corporation

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New York, N. Y.

UCC

Offices in
Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

THE LINDE AIR PRODUCTS COMPANY
30 East 42nd St., Room 308, New York, N. Y.

Please send me, without charge, the material I have checked.

☐ Conservation of Materials—Inspection Chart—Form 5206.
☐ Specimen Inspectors' Map of Oxy-Acetylene Piping System—Form 5207.
☐ Conservation of Materials—Control Chart—Form 5205.
☐ Handbook for the Oxy-Acetylene Operator—published by the International Acetylene Association.
(Specify the quantity of Handbooks required)..........

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LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks.

Beryllium Windows for X-ray Studies

Windows made of beryllium, which though opaque to light are more transparent to certain kinds of X-rays than glass, are speeding tests of materials used in bombing planes and other war machines, states the news bureau of *General Electric Co.,* Schenectady.

The X-rays are used to study the way the atoms are arranged. The lattice of atoms that make up the crystals of the metal diffract the X-ray beam. In the case of various alloys, it is possible to check the effect of heat treatment, which changes the molecular structure to make the metal stronger and more durable.

X-rays from chromium have many uses, but the Lindemann glass windows of the older tubes would transmit only 5 per cent, while 62 per cent is transmitted by the new beryllium windows. With the shorter X-rays from copper, 84 per cent is transmitted by beryllium as against 40 per cent for Lindemann glass.

With beryllium the speed with which diffraction patterns are obtained has been increased 15 times, and the tubes can be used for more exposures during their service life.

Though beryllium has previously been used for alloying copper with other metals, this is the first use ever found for it in pure form. It weighs 115 lbs. to the cu. ft.; aluminum, 168 lbs. Only magnesium, among similar metals, is lighter, weighing 109 lbs.

New-Type Stitching Wire

A new-type stitching wire has been developed by the *American Steel & Wire Co.,* Cleveland. Time savings by unskilled labor results as much as 90 per cent in the production of various sub-assemblies going into America's war planes.

By it, various types of materials are bound together, much as pieces of paper are stapled by the ordinary desk stapler. It is particularly adaptable to the fastening of rubber, plastics, fibre board, laminated wood and other construction materials to stainless steel or aluminum.

The new wire is of special analysis, with a guaranteed minimum tensile strength of 290,000 per sq. in. It has a zinc coating, which withstands a salt spray several hundred hours. Its diameter is close to .051 in., and it will penetrate stainless steel of .030 in. thickness, duralumin of .040 in. or aluminum of .060 in. thickness. Softer materials can be penetrated to a thickness of 3/4 in. Stitches can be made at the rate of several hundred per min.

● Metalead is a leaf lead paste product, successful as an ingredient of red lead and blue lead primer paints. It is specified extensively for structural steel primer paint compositions, and is used to protect steel surfaces exposed to extreme corrosive conditions. Other forms of lead powder suitable for powder metallurgical applications are also produced. All are manufactured by *Metalead Products Corp.,* San Francisco, represented in New York by *Advance Solvents & Chemical Corp.,* 245 Fifth Ave.

Aluminized Steel Sheets

Aluminized steel, a new specialty sheet metal, has been developed by the *American Rolling Mill Co.,* Middletown, Ohio, for use in products requiring exceptional resistance to heat and corrosion. This aluminum-coated sheet, with a mild steel base, combines the surface advantages of aluminum with the strength of steel. Corrosion resistance is equal to that of an aluminum sheet, the maker claims.

When exposed to corrosion, a tight oxide film, self-healing and inert, forms on the surface. The metal is passive in most atmospheres and resists "pinholing." It withstands temperatures up to 1000 deg. F. without discoloration, resisting severe oxidation at even higher temperatures. It will not peel or flake in moderate forming or drawing operations; paint will hold better than on galvanized sheets.

A 16-gage sheet uses only 5 per cent as much of the lighter metal as a solid aluminum sheet of the same thickness. Present aircraft applications include fire walls and air intake filters, with cowling being considered.

What it Takes for war-time heat treating!

Potentiometer Indicator by Foxboro. Available with 1 to 18 built-in switch points. See Bulletin A-305.

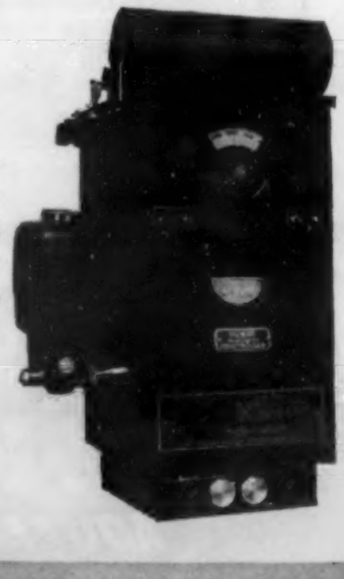
Tougher heat-treating standards demanded for war products now call for pyrometer precision higher than many pre-war jobs required. Today, just "good enough" won't do!

That's why you'll find Foxboro Potentiometer Instruments in use throughout many of the leading war plants. Foxboro's complete line of pyrometers *has what it takes* for close, dependable control of war-production furnaces.

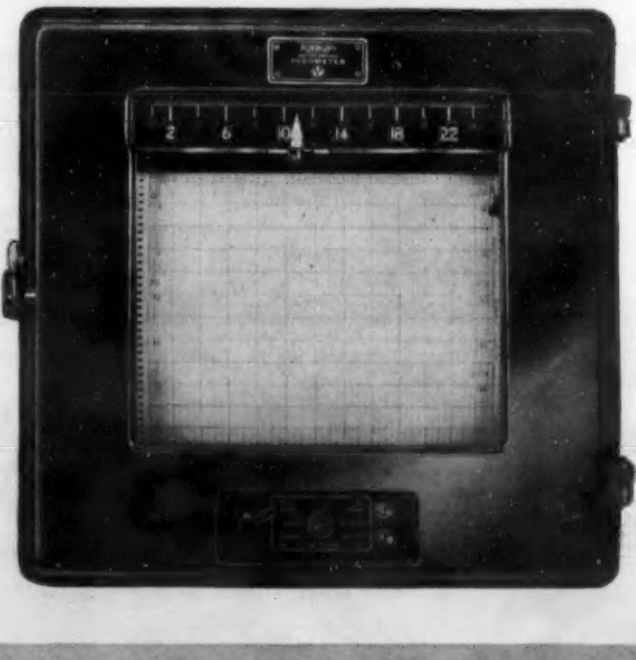
In all Foxboro Potentiometer Instruments . . . Recorders, Controllers and Indicators alike . . . exclusive Foxboro simplifications and refinements cut lost motion and wear to negligible minimums . . . furnish guaranteed accuracy of ¼ of 1% of scale, or better. In addition, these Foxboro features provide simpler, more exact setting by operators, due to use of larger, easy-reading scales.

Only four of Foxboro's Potentiometer Instruments are pictured here. Write for Bulletins covering the complete line. **The Foxboro Company, 54 Neponset Ave., Foxboro, Mass., U. S. A.** Branches in principal cities of U. S. and Canada.

Foxboro Portable Potentiometer Indicator. Industrial accuracy approaching laboratory standards. See Bulletin A-303.



Non-Recording Potentiometer Controller by Foxboro. Unique fixed slide-wire and group-drive. See Bulletin 202-4.



Foxboro Potentiometer Recorder. Makes records of 1 to 8 temperature points. See Bulletin 190-6.

Potentiometer Instruments by FOXBORO

Reg. U. S. Pat. Off.

News of Men, Societies, Meetings and Companies

Briefs on Associations, Promotions, Education

Fifty-eight *General Electric* technicians who were rushed to Hawaii to help repair the battleships California and West Virginia are to receive the Navy "E" pins. These ships had settled to the bottom with their decks awash at the Dec. 7 bombing of Pearl Harbor. Motors of these ships were covered by thick oil and muck and some were corroded by salt water. Working conditions were extremely inconvenient and all but impossible at times. As a precaution against gas, the Navy provided chemically-treated white ribbons, which the men wore. Should the ribbons have turned purple, that would have meant gas and hurried exit by the workers.

The New Jersey Foundrymen's Association, when issuing invitations to its meeting in Newark following the ban on pleasure driving, included a sticker for a windshield that read: "This car is being used for attendance at a business session of the N. J. Foundrymen's Association."

"Fundamentals of Foundry Engineering" is the name of a course being issued by the War Industries Training School of *Stevens Institute of Technology*, Hoboken, N. J., consisting of a course of free lectures. It is for foundrymen and all others interested, and the Government is financing it. Topics for the rest of the series are, starting with March 25: directional solidification of casting materials; melting and pouring; cleaning of castings; reclamation of foundry materials; annealing and heat treatment; and necessity of proper foundry control.

The American Society of Tool Engineers will hold its annual meeting and exposition in 1943, after all. It will be at Milwaukee, March 25 to 27. The committee is discouraging the exhibition of items of heavy equipment, suggesting the use of photographs and literature instead. Among the subjects treated will be: Increased mass production of ferrous and non-ferrous aircraft parts; use of plastic tools; glass plugs and ring gages; application of induction hardening processes; and new developments in welding.

The United States Civil Service Commission sends out a call for many types of technicians, including the following: Engineers, \$2,600 to \$8,000 (persons with education or experience in almost all branches of engineering); metallurgists, \$2,600 to \$5,600, and junior metallurgists, \$2,000.

The American Foundrymen's Association has nominated officers and directors to take office following the annual conference at St. Louis April 28-30. Officer nominations are: President, Lee C. Wilson, general manager, Reading Steel Castings Div., American Chain & Cable Co.; vice-president, Ralph J. Teetor, president, Cadillac Malleable Iron Co. Five directors to serve three years have been named: D. P. Forbes, Roy M. Jacobs, Max Kuniansky, Harry Reitinger and W. B. Wallis.

"Electric Arc Welding Machine and Electrode Standards" is a new publication of the *National Electrical Manufacturers' Association.* It is designated as Publication No. 42-81, and supersedes No. 36-37, issued in 1936. Copies can be had at a nominal price from the Association at 155 E. 44th St., New York.

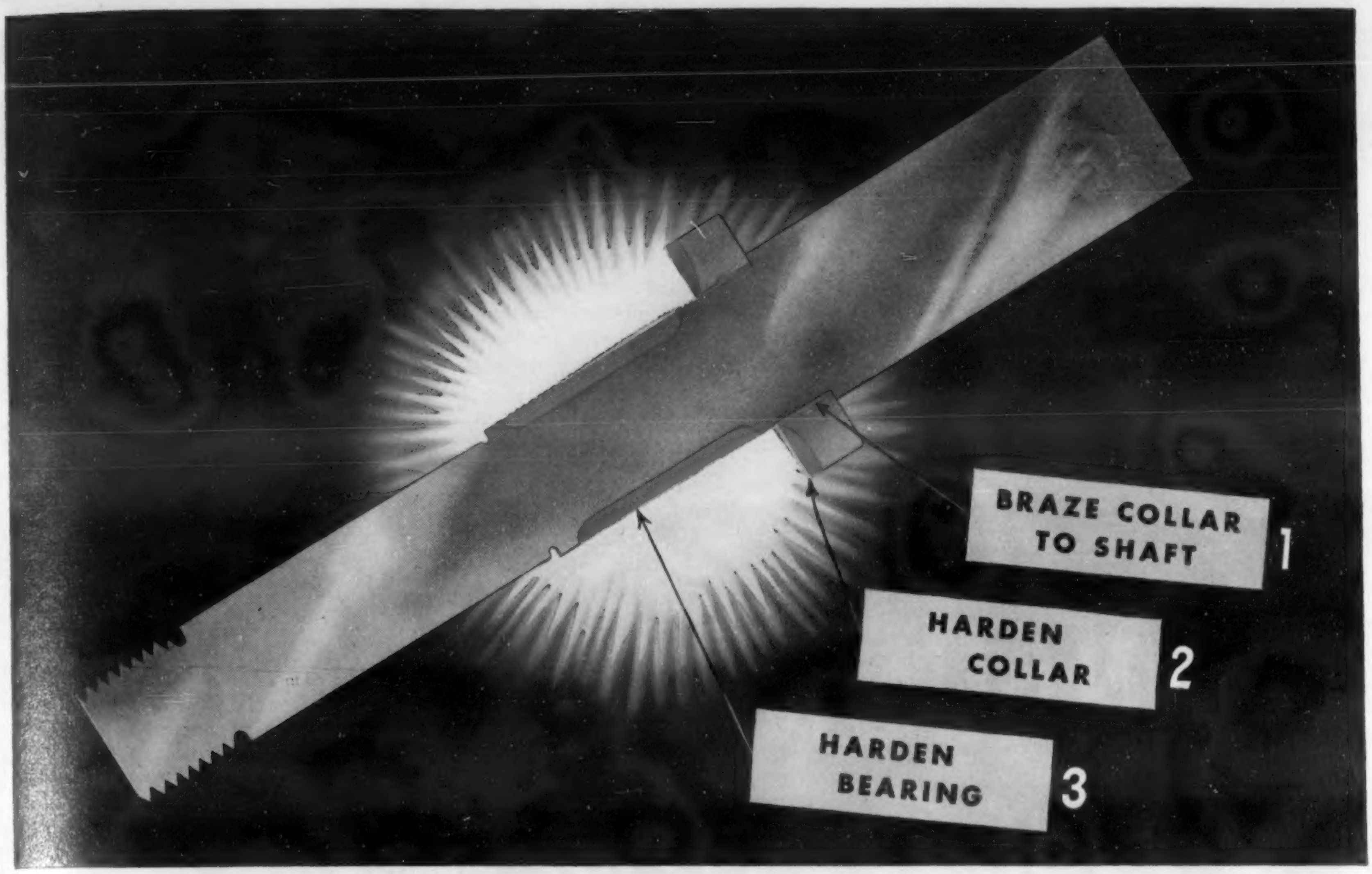
"Skis As Good as "C" Card — On Snowy Days" is the heading of a caption on a photograph received from Westinghouse Electric & Mfg. Co. It shows Dr. T. D. Yensen, head of the Magnetic Dept., Research Laboratories, arriving at work in a ski outfit. On snowy days he skiis 2½ miles from his home. On the return, he often gets a tow up the hills from some fellow scientist's car. He was born in Norway 58 years ago, which perhaps explains his skiing proclivities.

War workers' production ideas saved 1,250,000 man-hours in *General Electric* plants in 1942. A record of \$158,943 was paid for 16,204 suggestions adopted from 53,945 submitted.

"Transactions" of the American Foundrymen's Association is coming off the press, being Volume 50. It can be obtained from the executive office at 222 W. Adams St., Chicago.

Simple methods for determining the size of mineral particles to be tested in the laboratory are explained in a recently published *Bureau of Mines* circular, especially prepared for persons with no previous experience in sizing. The methods outlined include wet and dry screening and sedimentation, with directions for use of woven brass wire screen. Information Circular No. 7224 may be obtained free from the Bureau.

A tool engineering handbook is being published by the American Society of Tool Engineers, Detroit. Contributions from the 12,000 members are encouraged. As rapidly as data, charts, etc. are available, they will be published, rather than await final compilation of the handbook.



3 Jobs in 1 Operation Completed by TOCCO in 41 Seconds!

THE versatility of TOCCO Induction Heat-Treating is shown by its application to Diesel engine balancer shafts. In just 41 seconds, a 80 K.W. TOCCO unit performs these three treatments simultaneously:

1. Brazes thrust collar to shaft.

2. Heats and quenches thrust face of thrust collar to hardness of 56-58 R.C.

3. Heats and quenches bearing surface next to thrust collar to hardness of 45-55 R.C.

Cross-sectional drawing of this treated portion of the 1½″ shaft is shown above. Thrust collar formerly was upset on the shaft. The simplified design made possible by TOCCO cuts costs and conserves vital man-hours.

By a simple change of work fixture, the standard TOCCO unit that now speeds war production can be adapted to low-cost heat-treating of peacetime products. Investigate TOCCO for *your* present and post-war problems.

THE OHIO CRANKSHAFT COMPANY
Cleveland, Ohio

JUST PUSH A BUTTON

TOCCO

World's Fastest, Most Accurate Heat-Treating Process

HARDENING
ANNEALING
BRAZING
HEATING for forming and forging

Plants and Slants

A new division of a Detroit company has been formed, to be known as the *Aluminum Refiners Div., Bohn Aluminum & Brass Corp.* It will specialize in the refining of aluminum scrap into aluminum alloy ingot. The company pioneered in the use of aluminum scrap many years ago despite widespread belief that aluminum castings had to be made of virgin metal. Ten acres of land and 125,000 sq. ft. of floor space have been bought for the new enterprise. It is scheduled to start operations March 1st. Ernest Bell will be division manager.

Keystone Carbon Co., 2031 State St., St. Marys, Pa., has enlarged its operations in powder metallurgy to include production of small parts of special design and shape, which eliminates machining operations. Currently being produced are cams, eccentric parts, levers, rotors and slide blocks.

Willard Storage Battery Co., Cleveland, has provided a modern aluminum castings foundry and is producing high quality, heat-treated aluminum aircraft castings.

The Irvin Works, Carnegie-Illinois Steel Corp., near Pittsburgh, set a new world's record in January for monthly production and shipment of ship plates, enough for more than 75 large tank landing ships. It operated at better than 200 per cent of its originally estimated capacity.

Paul Revere built copper sheathing for the bottoms of the wooden men-of-war that fought for the United States in the War of 1812. Now the *Revere Copper & Brass, Inc., Michigan Div.,* has been awarded the Army-Navy "E" for high achievement in production of war equipment.

Budd Induction Heating, Inc., subsidiary of *Budd Wheel Co.,* is now in full production in its modern plant at Detroit. It is manufacturing induction heating equipment for customers filling war orders. The four-story plant was built with a minimum of critical war materials. One of the features is a glass bay in which heat-treating machines are assembled.

The Oil City Tank & Boiler Co., Oil City, Pa. has changed its name to *Electroweld Steel Corp.,* with entire production facilities now devoted to Electroweld tubing. One of the world's most modern electric resistance weld tube mills has been installed.

Completion of a portion of the first metallurgical coke plant on the West Coast is announced by *Koppers Co., Engineering & Construction Div.* It is made up of two batteries totaling 90 Koppers-Becker coke ovens, including equipment for recovery of all usual by-products.

The new core department at the plant of the *Cooper-Bessemer Corp.* at Mt. Vernon, Ohio, will embrace some of the latest methods of handling core sand by the carload in the most direct manner. It is considered one of the most modern core shops in the country.

News of Metallurgical Engineers

Hoy O. McIntire, associated with the Carnegie-Illinois Steel Corp. at its Gary sheet and tin mills, has joined the research staff of Battelle Memorial Institute, Columbus, where he will be engaged in metallurgical research and development. He took post graduate work in industrial metallurgical processes at Purdue University.

John C. Traphagen and *Robert L. Beattie* have been made directors of the International Nickel Co. The former is president of the Bank of New York. He holds several directorships and is trustee of Stevens Institute of Technology. Mr. Beattie has been with the company at Copper Cliff since 1911, except for service in the first World War. He became vice-president and general manager in 1942.

Dr. G. M. Butler, formerly research engineer in the Dunkirk, N. Y., laboratories of the Allegheny Ludlum Steel Corp., has been named chief metallurgist in charge of technical control and research. He obtained his doctor's degree in physical metallurgy at the Massachusetts Institute of Technology. Before becoming a research engineer on internal combustion engine valve steels at Allegheny Ludlum, he was associated with the U. S. Bureau of Mines and the Climax Molybdenum Co. *R. T. Eakin* has now been made assistant metallurgist at the same Allegheny Ludlum plant.

Chester Malysiak has been appointed to the research staff of Battelle Memorial Institute to assist in conducting research in non-ferrous metallurgy. He has had chemical and metallurgical positions with the Bingham Stamping Co., Owens-Illinois Glass Co. and Continental Steel Co.

Dr. Edward L. Mack, formerly of the faculty of Cornell University and for ten years director of research and development for the Reynolds Metals Co., has been granted two U. S. patents covering an improved type of fastening device for attaching the removable engine cowlings on high speed military airplanes.

Miss Mary M. Donovan has been appointed to the physics research division of Battelle Memorial Institute, and will specialize on the electron microscope. She attended the Carnegie Institute of Technology and the University of Pittsburgh.

A. W. Herrington, chairman of the Marmon-Herrington Co., has been made a director of the Army Ordnance Assn., whose objective is "to foster an understanding of industry's role in our national defense." Mr. Herrington is a prominent designer and builder of military vehicles.

Meetings and Expositions

AMERICAN GAS ASSOCIATION, War Conference on Industrial and Commercial Gas. Detroit, Mich. March 11-12, 1943.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Milwaukee, Wis. March 25-27, 1943.

ELECTROCHEMICAL SOCIETY, spring meeting. Pittsburgh, Pa. April 7-10, 1943.

AMERICAN CHEMICAL SOCIETY, National meeting. Indianapolis, Ind. April 12-16, 1943.

AMERICAN CERAMIC SOCIETY, annual meeting. Pittsburgh, Pa. April 19-23, 1943.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION, spring meeting. Chicago, Ill. April 20-23, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Davenport, Iowa. April 26-28, 1943.

AMERICAN FOUNDRYMEN'S ASSOCIATION, annual meeting. St. Louis, Mo. April 28-30, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace Conference. Cleveland, Ohio. April 29-30, 1943.

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trends

By Edwin F. Cone

Platinum and Palladium

Many war-developed industrial uses of platinum have appeared. Commenting on this trend, Charles Engelhard, president of Baker & Co., Inc., has said "as far as the future is concerned, it is likely that many of the war-developed industrial uses of platinum will remain when peace is achieved. It is also probable that palladium will continue to enjoy popularity as a jewelry metal for which it had won a place as an alternate to platinum before the war. In this field it will supplement rather than supplant platinum and probably also will continue to find with platinum increased industrial applications."

Using Old Blast Furnaces

The enlarging, relining and reconditioning of old pig iron blast furnaces, long in disuse, is one of the developments of the last few months. Two such stacks, one idle since 1930 and the other since 1932, have recently been put in blast. They are being operated at Granite City, Ill., by the Koppers United Co. for the Defense Plant Corp.

Steel Plant Expansion

The United States Steel Corp., either at the request of the Government or on its own initiative, is rapidly completing the largest expansion of plant facilities in its history, involving an aggregate expenditure of around $740,000,000. The corporation's share is $305,000,000. Most of the new plants are expected to be in operation by the middle of 1943, says Chairman Olds in a year-end statement.

Saving Tin

Cans made from the two electrolytically coated tinplate lines and from the bonderizing black plate line, which Inland Steel Co. installed last year, will save about 2,425,000 lbs. of pig tin annually, according to estimates.

Upkeep of Steel Plants

One result of the higher operating rate of the steel industry is naturally increasing costs for repairs and maintenance. Data for even 1941 are interesting. The American steel industry in that year spent $420,000,000 for this purpose — exceeding by more than 35 per cent the $305,000,000 spent in 1940 and almost 2½ times that for 1938, the last year of world peace. The output of the nation's furnaces in 1941 averaged 97 per cent of capacity, according to the American Iron and Steel Institute.

Saves Vital Steel for Shells

Saving steel by improved methods of manufacture is one of the chief aims of makers of products. One large company reports that more than 15,000 tons of steel have been saved through improvements in the manufacture of shells. When shells were first made by the company, forgings averaged 155 lbs. each. This weight has been constantly reduced until forgings average about 126 lbs. and further efforts to reduce weight are being made.

Cheaper Magnesium

The downward trend in the price of the light metals has reappeared, this time in magnesium. A price reduction of 2½c per lb. was ordered early in January or from 22½c to 20½c per lb. Aluminum was reduced some time ago to 15c. May further lowering of sales price be expected?

Silver

Consumption of silver during 1942 in the United States and Canada is estimated at 119,000,000 ounces. This is an increase of nearly 50 per cent over the 80,000,000 ounces in 1941, or about 4 times the yearly average of 29,000,000 ounces during the 10-yr. period 1931 to 1940. This refers to consumption in the arts and industries.

Structural Steel

There was a sharp decline in the bookings of fabricated structural steel all last year, according to the American Institute of Steel Construction. From a high of 313,953 tons in an early month of the year, the bookings fell to 45,972 tons in November, the lowest on record since the end of World War I. Shipments also declined — the November total of 127,052 tons was 30 per cent under the volume of November, 1941.

Iron Ore for 1943

The goal for iron ore shipments from the Lake region for 1943 is reported to be likely to be 100,000,000 tons. This compares with 93,000,000 tons for shipments by water and rail in 1942. This can probably be realized since the ore fleet will undoubtedly have a much larger carrying capacity this year. With new blast furnace capacity coming in, this large consignment of ore will be needed.

Women Welders

Among outstanding developments in 1942 were the employment of women as arc welding operators.